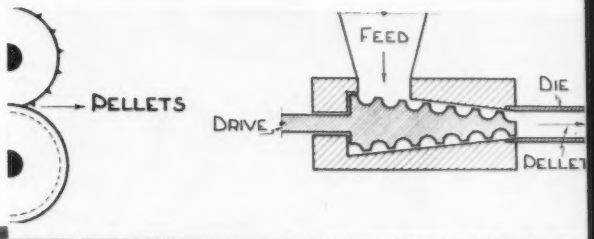
JUNE 1960

Agricultural Engineering

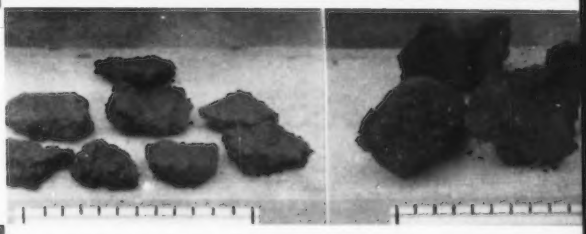
The Journal of the American Society of Agricultural Engineers

Production of Hay Wafers | 366



Molded Fiber Glass in Farm Equipment | 370

Size of Cut: Tillage Tool Efficiency | 372



Pipe Outlet Hydraulics for Tile Drains | 375

Unloading Silos Mechanically | 378

NEW PRODUCTS

N/D's new integrally sealed, heavy-duty conveyor ball bearing shuts out moist and dry abrasive contaminants . . . reduces assembly time and eliminates costly relubrication maintenance.

N/D Introduces New Heavy-Duty Cost-Cutting Conveyor Ball Bearing!

Now you can cut conveyor operating and assembly costs substantially with the *new* heavy-duty N/D conveyor roll ball bearing.

This durable N/D precision ball bearing for conveyors incorporates an exclusive integral seal combination—a new, highly efficient Land-Riding Seal and a performance-proved Sentri-Seal. Its minimum torque seal combination shuts out both moist and dry abrasive contaminants . . . and seals in bearing lubricant for life.

This high performance bearing helps cut manufacturing assembly time . . . and helps reduce field assembly costs. These modern design N/D ball bearings require no outmoded separate seal closures, lubricant plumbing, adjusting nuts, springs or collars . . . they're virtually maintenance free!

N/D sealed ball bearings are interchangeable with other type bearings and mount directly on commercially available rolled shafting. Install a few in your conveyor section . . . then compare the reduced maintenance costs to other type bearings requiring constant relubrication. The results will be convincingly in favor of N/D integrally sealed ball bearings . . . year after year!

For additional information call your N/D Sales Engineer, or send today for the new N/D Heavy-Duty Conveyor Ball Bearing Bulletin. Write New Departure Div., General Motors Corp., Bristol, Conn.

Replacement ball bearings are available through United Motors System and its Authorized Bearing Distributors.

NEW DEPARTURE

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proved reliability you can build around

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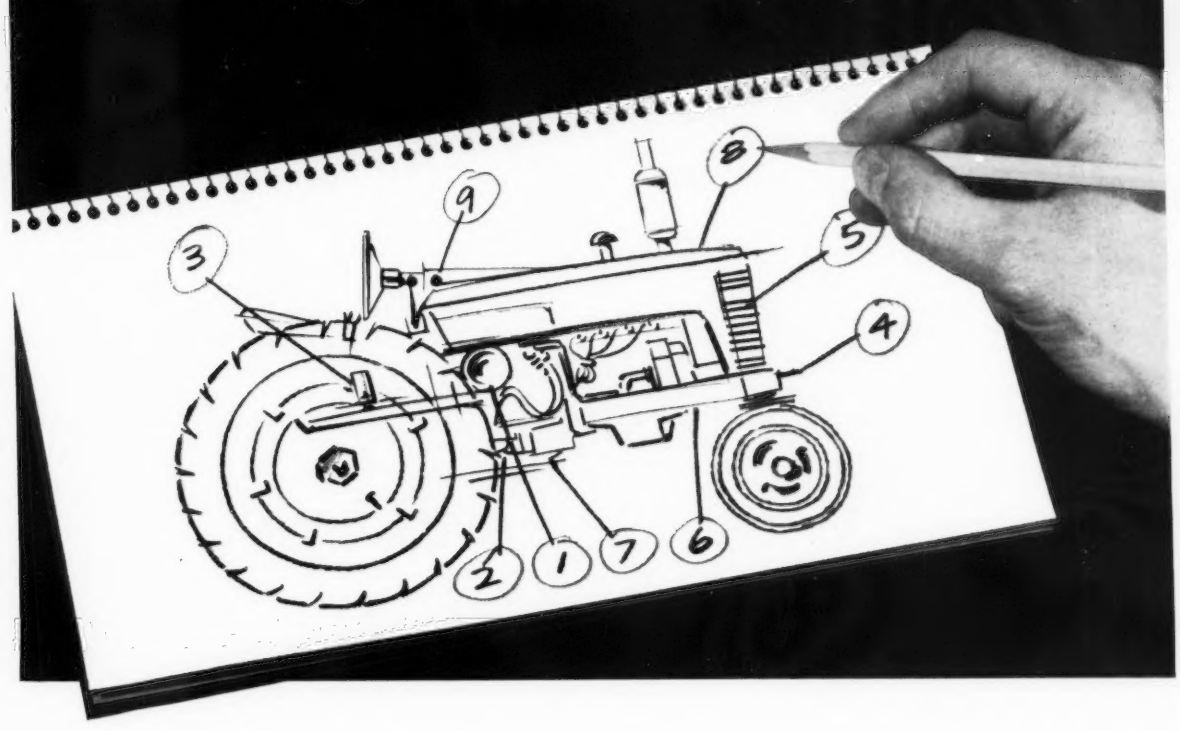
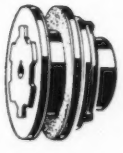


First—check these Morse power transmission components to solve many design problems!

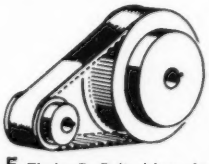
1 Taper-lock sprockets on side power-take-off shaft

2 H-E Roller Chain for power transmission



3 Morse torque limiter on power-take-off shaft

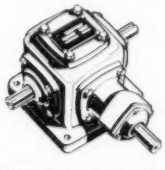
4 Morflex coupling on front-end drive shaft take-off



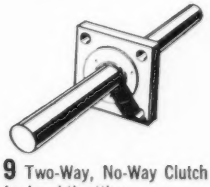
5 Timing® Belt drives for fuel injection application

6 Morse silent Timing Chains for tractor engines

7 Hy-Vo® Drives for drop-box transmission



8 Miter boxes for pto drives for saws or grinding wheels



9 Two-Way, No-Way Clutch for hand throttles

Morse power transmission components have wide proved-in-the-field application superiority. By designing them into your tractor or farm machinery, you can simplify and cut many hours off design problems . . . even lower production costs.

Examine these examples of Morse "exclusives". Then call in a Morse engineer to work with you from the start. His broad experience can be a valuable shortcut to a better product for you. Call or write: Morse Chain Company, Dept. 38-60, A Borg-Warner Industry, Ithaca, N. Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ontario.

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Agricultural Engineering

Established 1920

CONTENTS • JUNE, 1960 • Vol. 41, No. 6

Report to Readers 344

Conference Features Confinement Housing of Livestock . 365

Production of Hay Wafers 366
John B. Dobie

Molded Fiber Glass in Farm Equipment 370
D. E. Brail

Relation of Size of Cut to Tillage Tool Efficiency . . . 372
W. R. Gill and W. F. McCreery

Hydraulics of Pipe Outlets for Tile Drains 375
W. D. Lembke

Unloading Silos Mechanically 378
Martin Decker

Agricultural Engineering Phases of Teacher Education in Agriculture — Report III. Pre-Service and In-Service Education Programs 382

News Section 386

ASAE Members in the News 388

With the ASAE Sections 390

New Products 396

Manufacturers' Literature 400

Personnel Service Bulletin 402

New Bulletins 403

Research Notes 404

New Books 404

Index to Advertisers 408

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Premiere Showing of Motion Picture

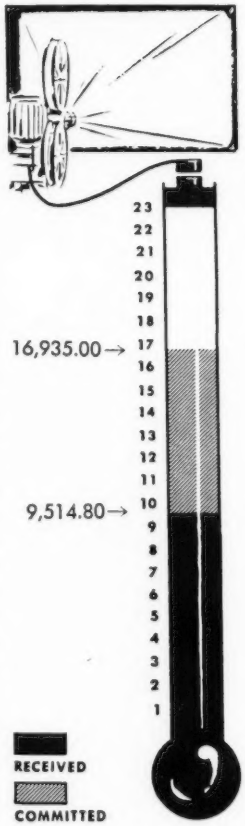
THE ASAE Motion Picture "Progressometer" made an upward surge during the moth of May, as the first of the contributions from industry came in. A total of $2,212.00, $1,700.00 of which resulted from industry contributions, was received during the month, bringing the total of cash received to $9,514.80. Commitments also increased to $16,935.00, only $6,065.00 short of the estimated goal.

Contributions by industry to the Motion Picture Fund have resulted from a letter sent out by ASAE President L. H. Skromme during May and June in which he pointed out the joint responsibilities of educational institutions, the professional society, and employers in providing qualified agricultural engineers to meet the expanding needs of the future. Early returns indicate that industry is cognizant of its stake and is willing to do its share.

Another interesting development occurred during the month when a purchase order for one copy of the film was received from North Dakota Agricultural College. W. J. Promersberger, chairman of the agricultural engineering department, explained that the North Dakota Student Branch raised the major portion of the money toward purchase of the film.

Production of the picture is progressing on schedule. Final editing is being completed and prints will be available for delivery by June 20. ASAE members will have an opportunity to witness a premiere showing of the film, which is scheduled as a feature of the ASAE annual banquet to be held, Wednesday, June 15.

The Cabinet Meeting, scheduled for Sunday, June 12, during the ASAE Annual Meeting, will be devoted to various career promotion activities. A five-step plan of activity developed around the ASAE motion picture will be described in detail and copies of various pieces of promotion literature will be displayed during the meeting. In addition, the executive director of JETS, the national high school engineering organization, will be on hand to explain how agricultural engineering can play a more important role in the programs of that organization, whose members consist of high school students especially interested in engineering careers. Information will be given concerning a new Texaco motion picture, describing career opportunities in agricultural engineering, and special provision will be made for display of career brochures now being used throughout the country.



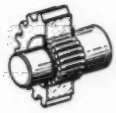
Now you can get highest capacity at lowest cost with Torrington Needle Rollers

A hardened shaft, a hardened housing, and precision Torrington Needle Rollers provide the most economical, highest capacity anti-friction assembly you can obtain.

Six roller end shapes permit design flexibility whether the requirement be maximum effective roller length, proper fillet clearances or greater lip retainment. Torrington Needle Rollers are available in a complete line meeting SAE and AFBMA specifications. Torrington standards for material, heat treat, tolerance and finish of Needle Rollers are the highest in the industry.

Operating results with Needle Rollers depend on careful design of mating parts. Torrington's Engineering Department, with extensive experience in Needle Roller application, will be glad to give you technical advice on your needs.

Full complement of small diameter rollers insures maximum number of contact lines in load zone for high radial capacity in minimum space.



Mounted without races between hardened shaft and hardened housing (RC-60 recommended), Torrington Needle Rollers allow largest possible shaft diameters.

Carefully hardened, ground and lapped high carbon chrome steel makes each Torrington Needle Roller a precision part for long life performance.

Close tolerances are assured by stringent quality controls. Standard OD tolerance is .0002", but Torrington Needle Rollers can be supplied with tolerance of .00005". Tolerance on length depends on end shape.

Fine finish reduces friction to a minimum. Torrington Needle Rollers are usually polished to 4-6 rms, but finishes as fine as 1-3 are available on special order.

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SPICER COMPONENTS HELP SOLVE

For over 50 years Spicer clutches and drive train components have been designed into a large variety of agricultural machinery.

Spicer clutches for agricultural equipment include:

Split-Torque Type Clutches which deliver torque flow from one power source to do two *different* jobs. Available in sizes from 8½"-12", with nominal torque capacities ranging from 165 to 390 lbs. ft.

Spring Loaded Type Clutches for smooth steering and/or master clutching on tractors as well as other specialized and conventional equipment. Available in sizes from 6½"-12", with torque capacities tailored to specific requirements.

Constant Pressure Type Clutches — Used with live PTO's on wheeled tractors, heavy-duty crawler tractors and other off-highway applications. Available in sizes from 6½"-17", with nominal torque capacities ranging from 93 to 1420 lbs. ft.

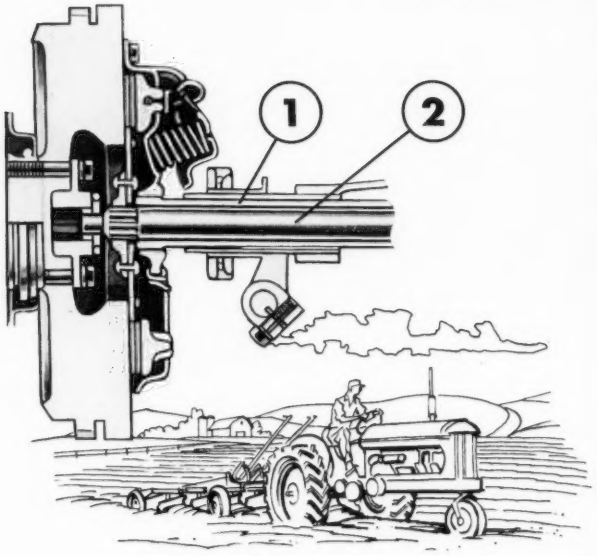
Dual Drive Type Clutches supply selective drive to both tractor and implements with single pedal control. 9"/11" size has a nominal torque capacity of 152-202 lbs. ft. The 10"/12" size has a capacity of 261-306 lbs. ft.

Dana manufactures a wide variety of smaller axles for incorporation into self-propelled agricultural equipment designs where axle carrying capacities from 1000 to 5000 pounds are required. A complete range of gear ratios is available in the popular models.

Since the axle tubes are pressed into the center section, Spicer axles can be adapted to a great many variations in mounting arrangements as well as tread and wheel end design, by changing only the axle shafts and tubes. The center section is not affected. The economic advantages of this flexibility are evident in low piece prices and minimum tooling costs.

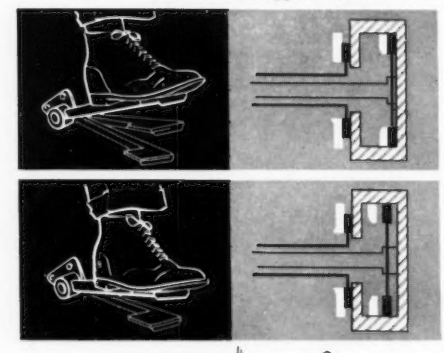
Spicer Telescoping Square Propeller Shafts are available for use with all types of agricultural PTO applications for continuous or intermittent service. No welding or realignment necessary.

Write now for information on the complete line of Spicer clutch and drive train components.

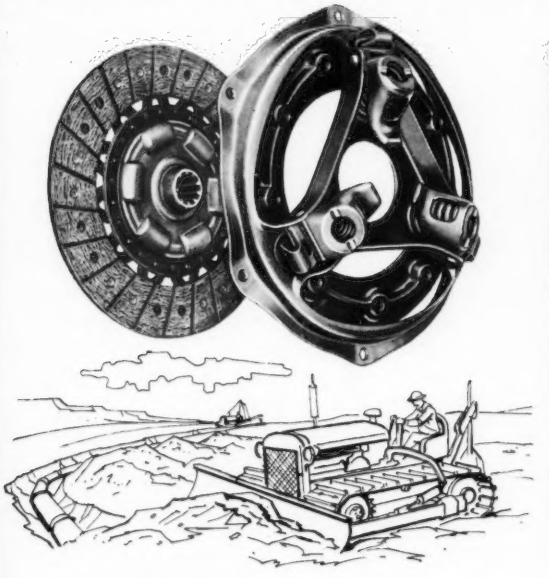


Split-Torque Type Clutches

Dual Drive Type Clutches



POWER TRANSMISSION PROBLEMS!



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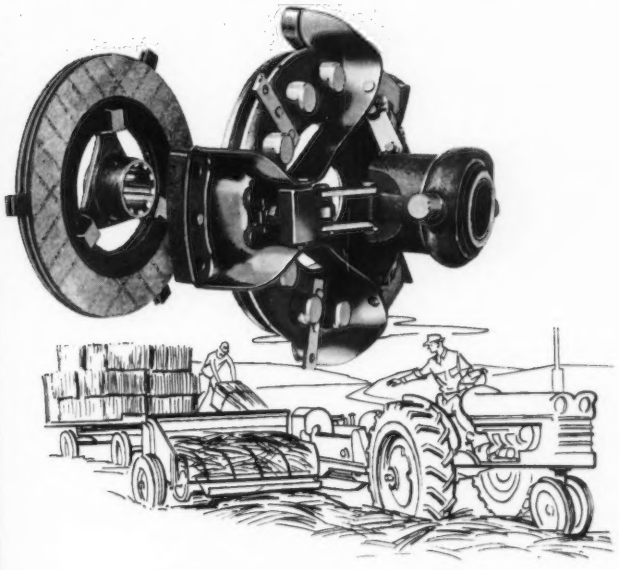

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Spicer Axles

Tree Knocker developed by P. A. Radocy & Sons

Spicer Telescoping Square Propeller Shafts

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Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

TWO-WAY OLIVER Husks or Shells

Saves more corn 3 big ways

Top capacity... low cost!

- One-year guarantee of parts.
- Interchangeable husker and sheller units.
- Three roller gathering chains per row.
- Special-design snapping rolls.
- Deep, sway-back center elevator.
- Husky, tubular main frame.
- Modern safety-clutch protection.

Pick your method—husk or shell. Then choose a convertible Oliver 73 to save more of your corn three big ways.

ONE: Oliver's three roller gathering chains per row, combined with "live," open-end roll points, reach right down to ground level to pull in hard-to-get "down" stalks.

TWO: Specially designed rolls control the position of the ears when snapped to reduce shell-off.

THREE: Ears are shed quickly to cut shell-off losses still more. A sway-back elevator reaches deep into the gathering unit, follows the incline of the snapping rolls to catch ears sooner.

And however you go—husking or shelling—you'll get extra capacity in the Model 73, America's *newest* picker for 100-plus crops. Eight 47-inch-long rubber and metal rolls in the husker strip the flood of ears gently and fast. In the sheller, a spacious, round-bar cage minimizes cracking, handles the heaviest hybrid yields with ease.

Get the facts on how much you can save with a convertible Oliver 73, and the extra dollars Oliver's 6% cash bonus trade-in puts into your pocket.

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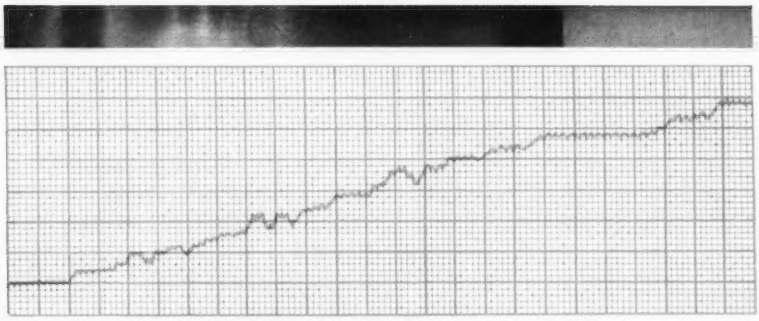
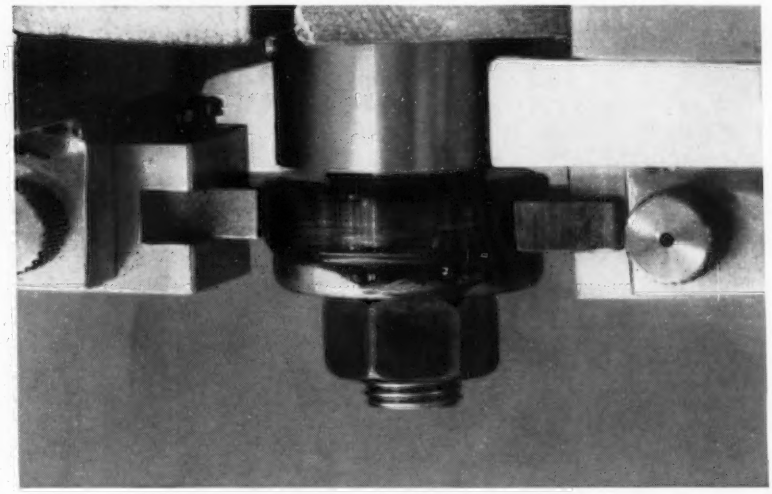
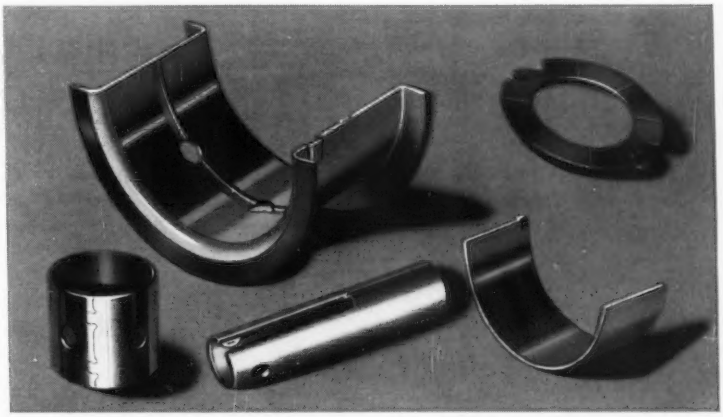




TO TAPE-RECORD THE "HEARTBEAT" OF BEARING METALS UNDER LOAD, WE USE THIS SPECIAL FRICTION AND WEAR TESTER. (left) The result is highly accurate data on the behavior of bearing-metal surfaces, invaluable in our fundamental research into friction. By means of this instrument, we're able to correlate, more closely than ever before, specific alloy compositions with their degree of the "stick-slip" phenomenon (in which one surface sliding over another slides . . . stops . . . slides . . . stops . . . and so on) which accompanies unlubricated sliding action. We can also determine accurately the compatibility of bearing materials with shaft metals in lubricated systems . . . showing us which metal or alloy is most likely to be superior for a given bearing application. In short, this Friction Tester is a fundamental research tool which gives us positive answers to difficult bearing problems, faster than ever before.

ONE REASON WHY F-M SLEEVE BEARINGS and other F-M products give you the finest possible performance — this and the other unusual precision equipment used by Federal-Mogul research. You'll find F-M sleeve bearings used in turbines, engines, and countless other types of power transmission equipment . . . F-M precision thrust washers in pumps, automotive engines and transmissions, motors . . . F-M formed bushings in refrigeration compressors, electric motors . . . and low-cost F-M spacers in motor mounts, machinery, control mechanisms. These are just a few examples.



There's much valuable data in our Design Guides on sleeve bearings, thrust washers, and bushings; and in our brochure on spacers. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

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Report to Readers . . .

SUBSURFACE APPLICATION OF VOLATILE HERBICIDES

A USDA plant physiologist and agricultural engineering research team, in research studies at the Mississippi AES, have been developing the subsurface application of volatile herbicides, a new technique that increases the effectiveness of these evaporative-type weed killers. An experimental, tractor-powered, two-row, rear-mounted cultivator-sprayer was used to apply the herbicide in a thin band under the surface of seedbeds before planting cotton. . . . . This treatment was found to control 90 percent of the weeds, compared to 74 percent when the chemical was sprayed on the surface and mixed with the soil with a rotary hoe. (Mixing the soil with the rotary hoe after subsurface spraying did not increase weed control.) It is believed this technique can be used in several ways to apply various chemicals to control weeds in different crops. . . . . The main parts of the spraying device are two V-shaped blades, turned sideways, which move horizontally at depths of 2 to 6 inches, without collapsing built-up seedbeds. The nozzles operate under a pressure of 40 psi and are installed in the V formed by each blade. The device was found to be effective at speeds up to 5 mph in loam soils.

EXPOSURE TESTS HELP DETERMINE EXPECTED LIFE OF FARM FENCING

Over the past 24 years exposure tests of woven-wire fencing have been in progress at Ithaca, N. Y., under the direction of Cornell agricultural engineers. These tests indicate, for this particular site, that average yearly loss of zinc is about 0.05 ounce per square foot to 100 percent rust. . . . . More than 900 samples, included in 16 major groups, have been under test. Of these only the extra-heavy, zinc-coated specimens, together with certain corrosion-resistant steel wire have not rusted. Cold-drawn steel wires made of 12 to 14 percent chromium steel first showed slight rusting at the late 1959 inspection. . . . . These exposure tests are useful in that they supply information for determining the expected life of a fence, which together with its initial and annual costs will enable a purchaser to decide on the quality of fence to buy for a particular use.

MECHANIZED CHERRY HARVESTING MAY PROVE A STITCH IN TIME

Michigan will this year harvest an estimated 71,000 tons of red tart cherries. Last year's crop required 45,000 workers, more than three-fourths of whom came from outside the orchard owner's community. And the supply of experienced migrant workers is drying up. . . . . Accordingly a team of Michigan SU and USDA researchers is looking to mechanized harvesting and handling as the solution of the problem. The agricultural engineers of this team have developed a hydraulically operated boom-and-claw shaker that mounts on the rear of a tractor. About 95 percent of the fruit is shaken off without injury to the tree. Various stretched-canvas collecting devices are used to catch the cherries as they drop from the tree. . . . . The researchers say this system is not as yet perfect, but they rate it as a big step toward the success of mechanized cherry harvesting.

ENGINEER WARNS OF DANGER OF BACKWARD TRACTOR TIPS

A Michigan SU farm safety specialist refers to backward tips, most frequent in the spring and on soft ground, as the "deadliest of tractor mishaps." When a tractor mires in soft ground, the temptation is to rock it back and forth, with the usual result of worsening the situation. . . . . When rear tires have mired more than 12 inches deep, backing up is the only safe way out. An operator is inclined to think he can disengage the clutch in time to prevent a backward tip, but, as the MSU engineer points out, "he has less than 2/5 second to prevent a tip once it starts." . . . . A low drawbar for all pulling is always advisable.

(Continued on page 346)

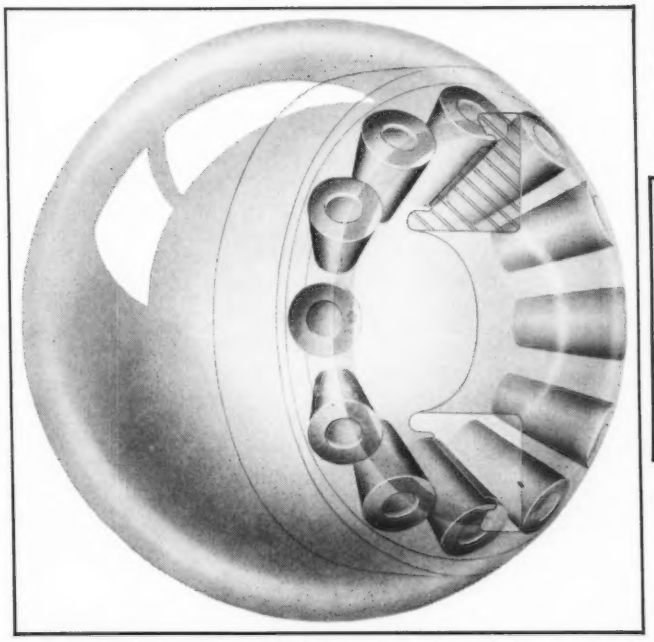
TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

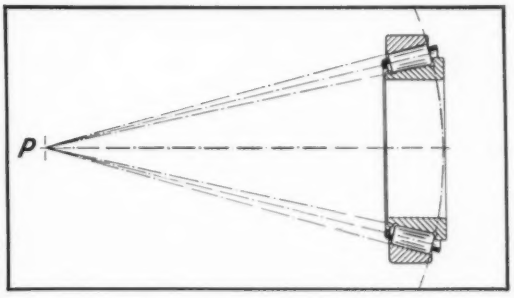
One in a series of technical reports by Bower

BEARING BRIEFINGS

SPHERICITY—ESSENTIAL TO MAXIMUM BEARING PERFORMANCE



When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.



True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. *It will always roll in this one path precisely, without sliding or skewing.* But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers *and* the raceway have a true spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would *touch all points on each roller's head!*

In effect, then, each roller's taper determines the radius of a hypothetical sphere whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

SOLAR ENERGY HOLDS PROMISE OF LOWER COST GRAIN DRYING

A research team of USDA-Kansas AES agricultural engineers are saying that farmers may soon be using solar-heated air as a more efficient, less expensive means of drying grain. They report that, in initial experiments, corn was dried better and faster by a solar-heated-air system than by a conventional unheated-air system. Also, fans of the solar installation used about 50 percent less electric power. . . . . It appears from the researchers' preliminary observations that grain containing up to 18 percent moisture can be dried adequately by use of a solar-heated air system, even if the sun shines only 3½ to 6½ hours a day. On account of faster drying, such a system will use only about half the electric power that would be required for moving unheated air. This will be the case whether air flow is continuous or fans are controlled to operate only when relative humidity is less than 85 percent. . . . . The engineers also observe that, in using in-storage drying, it will not likely be found profitable to increase the flow of solar-heated air above that normally recommended for unheated-air systems. The reason is that, while a greatly increased air flow usually results in much faster drying, it also adds to the cost of electricity.

MOISTURE MEASUREMENT BY NEUTRON SCATTERING

Cornell agricultural engineers are developing specific techniques for the most efficient use of a new procedure for measuring soil moisture in their irrigation and drainage research studies. Of the many methods that have been developed to speed this time-consuming operation, one based on the principle of neutron scattering holds much promise for rapid, accurate moisture determinations. The nuclear moisture meter which has been used in Cornell irrigation, drainage and rural road research, has demonstrated the versatility of equipment using this principle.

HENS LAY THE EGGS AND MACHINES GATHER THEM

Automatic operation in poultry production has moved another step forward with the introduction of new, automatic machines for egg gathering. This equipment not only saves labor but the eggs are cleaner and fewer are cracked or broken. . . . . The machine consists of three rows of metal nests, each equipped with a special rubberized fiber bottom. A hole in the bottom of each nest permits the eggs, as they are laid, to roll out onto a conveyor belt, which delivers them to the egg room. . . . A feature of this automatic nest is that the bottoms of all nests in each machine can be lifted mechanically, thereby forcing all hens off the nests at a time preset by a time clock.

MECHANICAL BAIT APPLICATOR FOR POCKET GOPHER CONTROL

California AES agricultural engineers announce a new means of controlling pocket gophers in pastures and open fields. For this purpose they have developed a mechanical bait applicator, which preliminary field trials indicate has promising possibilities. . . . . This applicator makes an artificial burrow at depths of 7 to 11 inches below the soil surface into which the poisoned grain is metered. If artificial burrows are made across a field at regular intervals of from 15 to 30 feet and at the proper depth, the engineers believe enough of the natural burrows will be intercepted to provide access for the poisoned bait. . . . . In field tests, several different mixtures of poisoned grain at application rates of 1¼ to 4 pounds per 1,000 feet of furrow have been used. Where artificial burrow spacing was 20 to 60 feet, counts of remaining active burrow systems indicated kills of 50 to 75 percent. . . . . The applicator is designed for mounting on a 2 to 3-plow tractor with conventional three-point hitch. It is to undergo further extensive tests to determine the most acceptable and the best amount of bait to use, as well as the most efficient spacing of artificial burrows under various field and gopher-population conditions.

RARE SAND PROVES BEARING DESIGN

in new 100,000-mile test!

The automotive shaft bearing above has just completed the equivalent of 100,000 miles of dusty backroads travel. For hours, it's been alternately spun and stopped in this special mud . . . mud composed principally of a rare type of Arizona sand, *so fine it penetrates almost anywhere water can go.*

The particles of this unique sand are so small that, mixed with water, even filtering won't remove them all. They're highly abrasive, too—so much so that bearing failure quickly occurs whenever particles penetrate into a bearing raceway. Though several score of spin-and-rest cycles in this bath are equal to 100,000 miles of heavy-duty use on the road, the BCA bearings tested on this machine consistently stand up under many more cycles, before failure from sand penetration.

This test is typical of the many being conducted in BCA's new testing laboratories for BCA customers. Here, and in the expanded research laboratories, testing of bearings to exceed customer specifications is a daily occurrence. Often test equipment is specially built to exactly duplicate equipment in the customer's plant.

BCA provides a wide range of ball bearing sizes and types for nearly every kind of industry. This, plus extensive new research, testing, and precision production facilities make BCA a dependable source of long-life bearings. For information, write Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pennsylvania.

BCA

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ball bearings

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

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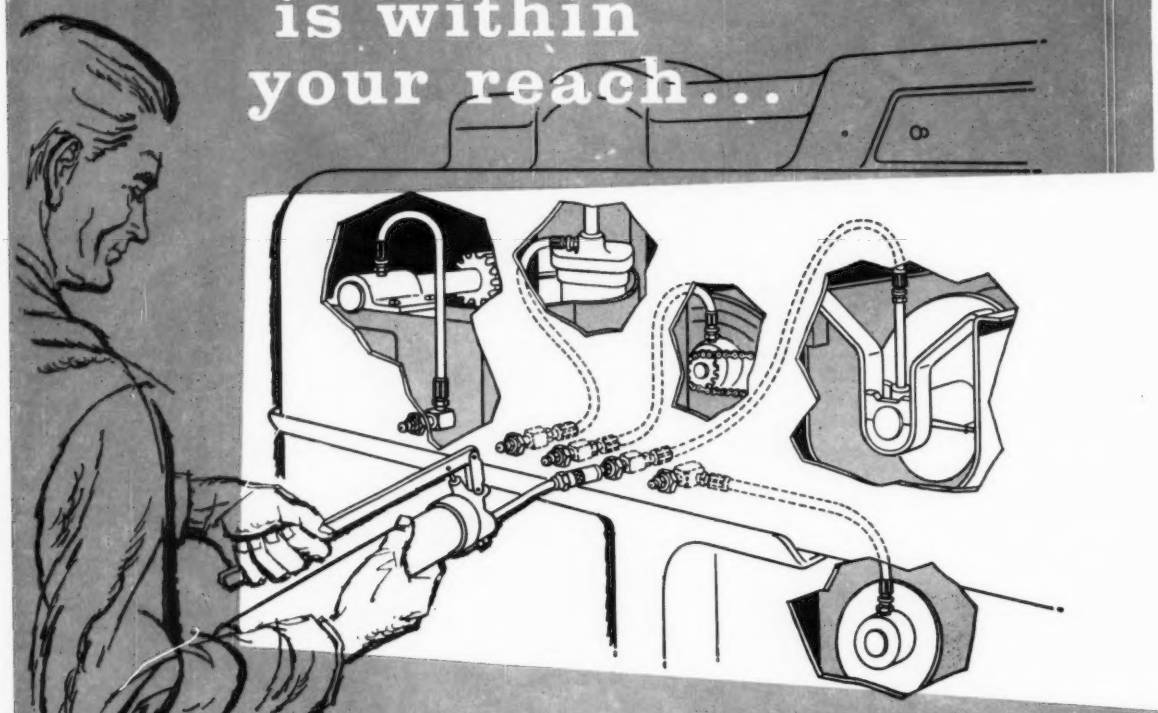
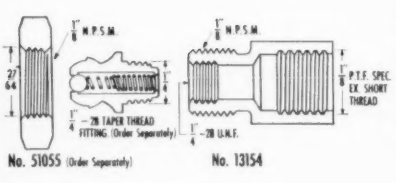
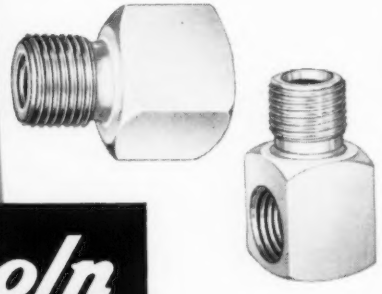


WITH LINCOLN'S BANK-LUBE SYSTEM





Proper lubrication of the machine you design is vital to its efficient operation and service-life. If some of your grease fittings are necessarily obstructed by a shield or bulkhead, your customer probably won't give them the attention they require, unless you make it easy for him.

Lincoln makes this easy for *you* with its high-pressure Bank-Lube System, which brings those hard-to-reach lubrication points out of the "middle of the stream" to the bank. Straight nipple and 90° elbow fittings are available for bulkheads up to ¼" thick. And Lincoln offers a complete selection of other components—adapters, connectors, and rubber, steel or Nylon feed lines.

The Bank-Lube System is simple to install, and permits even your smallest machine units to be included in a standardized lubricant application program at rock-bottom cost. For further details, write today for Design Engineers' Manual 92.

Lincoln

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Division of The McNeil Machine & Engineering Co.

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Link-Belt offers augers in a full range of diameters, gauges and pitches . . . with helicoid, sectional and many other types of flighting. For further details plus any engineering counsel you may need, contact your nearest Link-Belt office. Remember to ask for Book 2989.

JOHN DEERE 14T Baler conveys and compacts the windrowed hay into the baling chamber with a Link-Belt screw conveyor.

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PERFECT CIRCLE PRECISION CASTINGS

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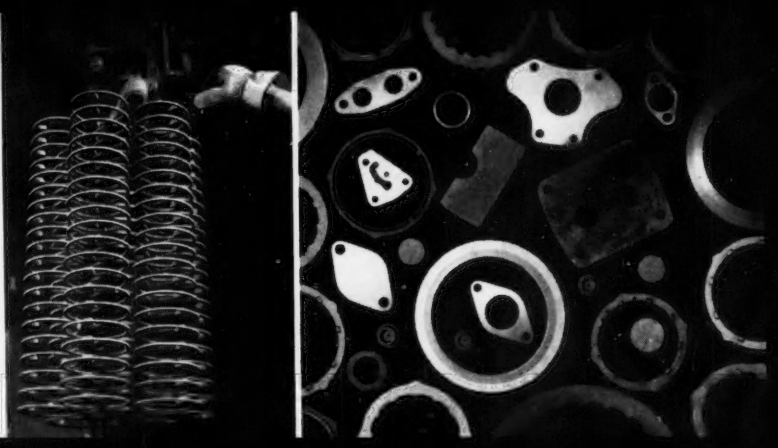
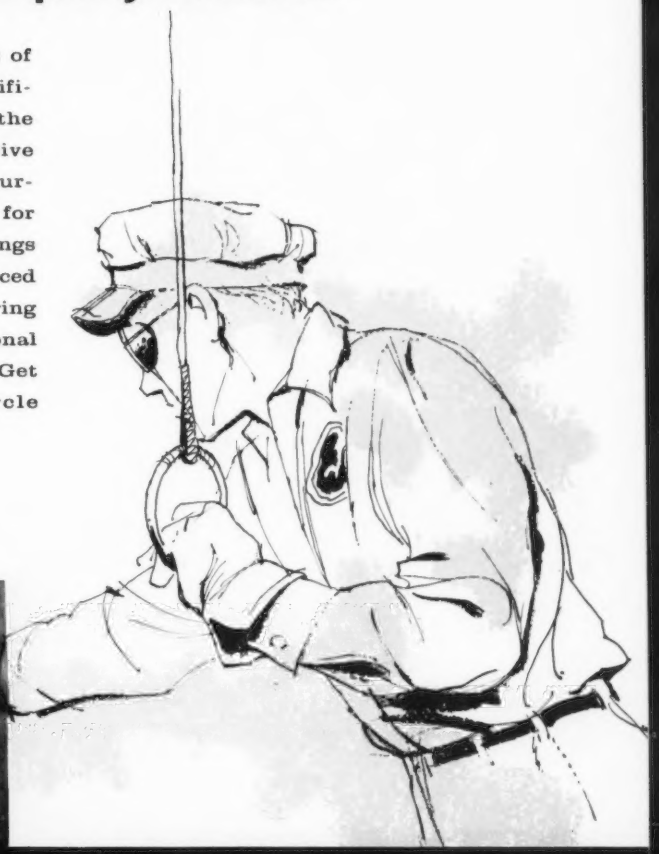
Molds of carefully-controlled green sand are made from the pattern plate, and stacked for pouring. In the example shown above after shake-out, the castings are 6-up in a stack 20 molds deep. Typical castings produced by this Perfect Circle process include piston rings, thrust plates, valve lifter facings and piston groove inserts.



Mass-produced to the highest quality standards

Every year, Perfect Circle produces millions of piston rings—all made to the exacting specifications that have set precision standards for the industry. Now, as the result of extensive expansion, the modern facilities and metallurgical skills of Perfect Circle are available for volume production of superior gray-iron castings to your specifications. And, through its advanced production techniques, Perfect Circle can bring you the finest metallurgical and dimensional precision at important cost advantages. Get complete information on Perfect Circle castings today!



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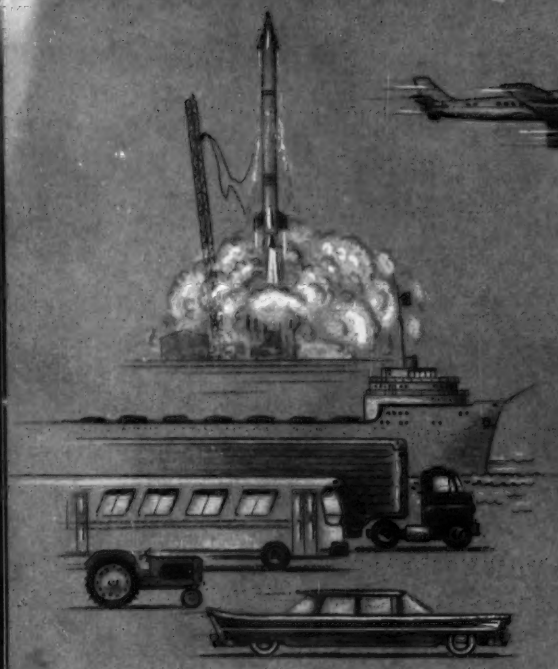
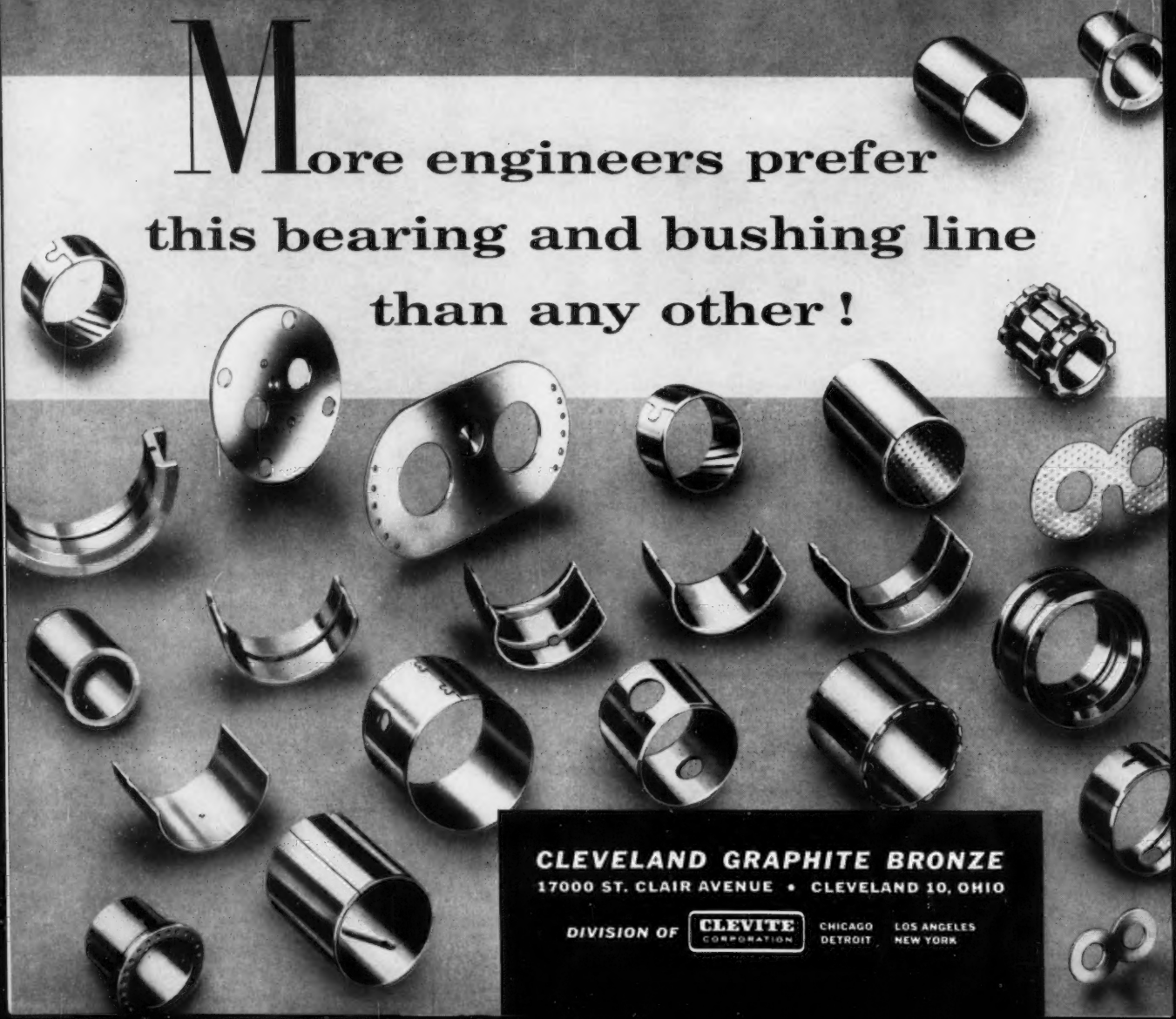


Engineers who specify original equipment bearings for most American cars, trucks, tractors, construction equipment, aviation-missile equipment, and Diesel and marine engines prefer Cleveland Graphite Bronze for reasons like this . . . They know CGB has pioneered in bearing and bushing design, having designed and introduced the majority of types now in use. *You are assured of a bearing, bushing or washer engineered to your specific application.*

Add to this the skill of CGB as a high quality precision manufacturer—with many exclusive production techniques. The continuous casting of babbit or copper-lead to steel strip is just one example. *Engineers are thus assured of top performance—long, trouble-free life.*

For prompt attention to your application—write, wire or phone—a qualified engineer will work with you.

More engineers prefer this bearing and bushing line than any other!



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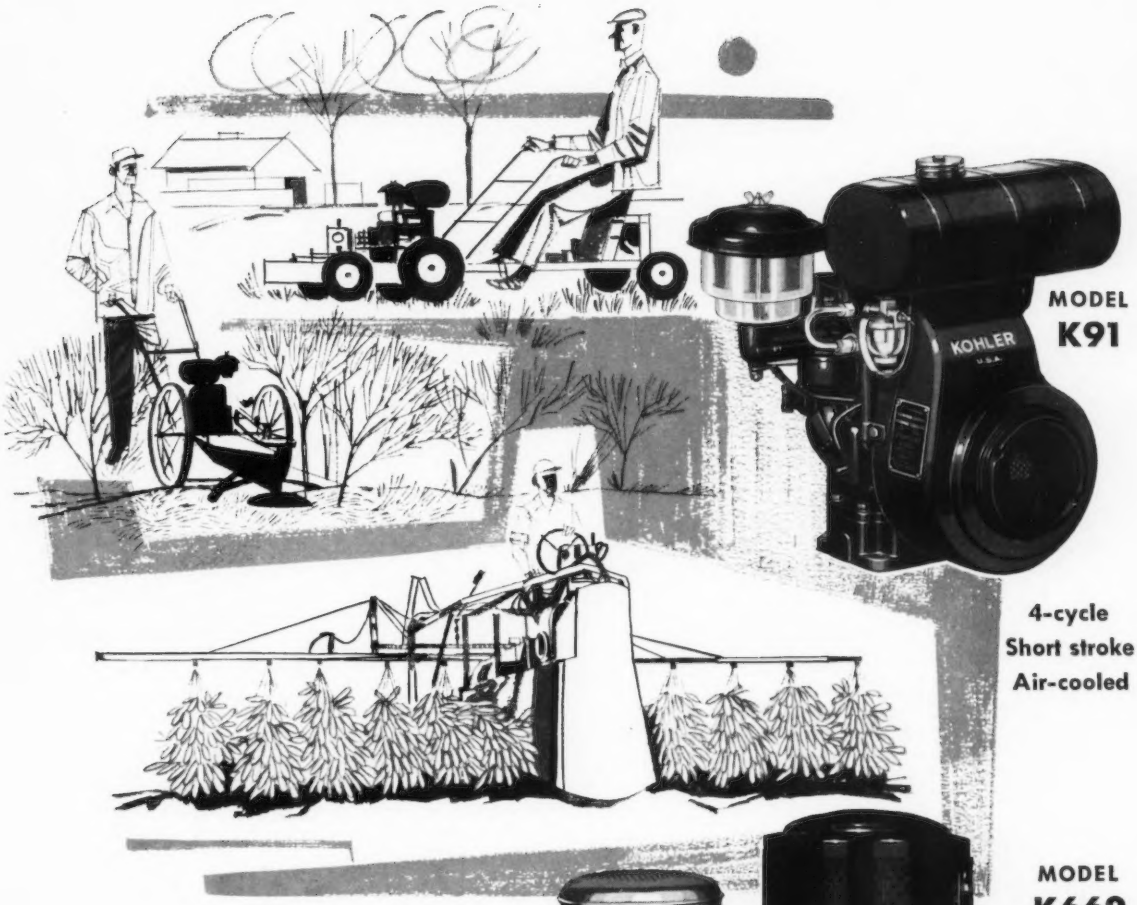
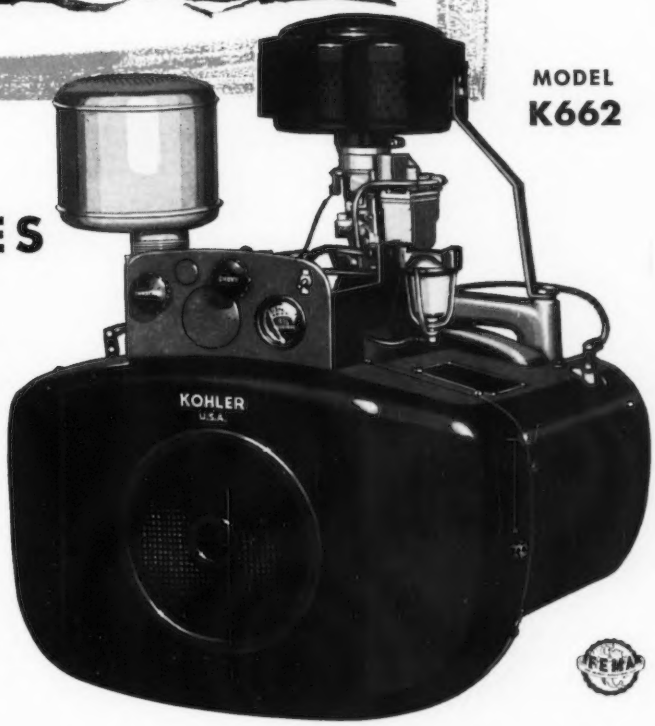


MODEL
K91

4-cycle
Short stroke
Air-cooled

MODEL
K662



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Reliable power for agricultural equipment

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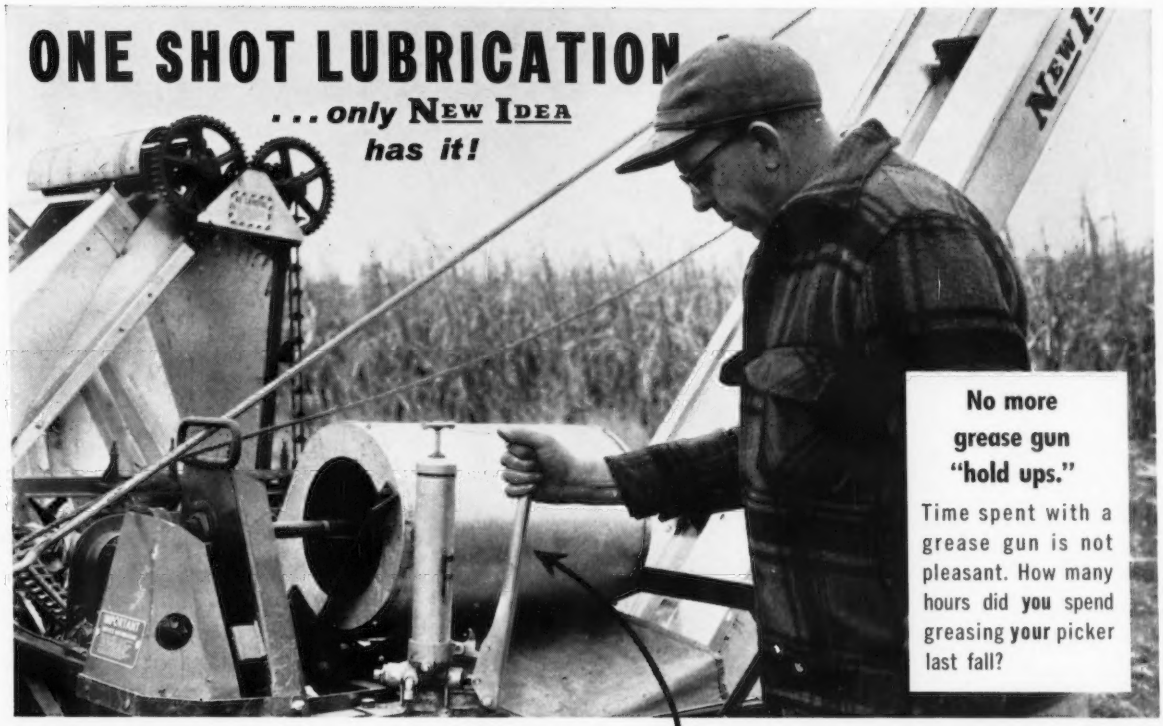
. . . only NEW IDEA *has it!*



No more grease gun "hold ups."

Time spent with a grease gun is not pleasant. How many hours did **you** spend greasing **your** picker last fall?

With one push on this lever he lubricates all 42 bearings on his NEW IDEA 2-row picker

Best selling pull picker in the corn belt. Now you can get it with or without One Shot lubrication. Either way, NEW IDEA picks cleanest . . . husks cleanest . . . gets more down corn.

The NEW IDEA 2-row pull picker shown here is factory equipped with NEW IDEA's exclusive One Shot lubrication system, newest and most efficient method yet developed for lubricating a corn picker.

One Shot lubrication is fast and foolproof. It makes greasing your picker as easy as shifting gears on your tractor. Lever action feeds special lubricant through nylon and steel tubing to all bearings except universal joints and wheels.

No points are overlooked or forgotten. Fittings don't get clogged or frozen. One stroke each time you change wagons keeps your picker greased to perfection.

The streamlined NEW IDEA 2-row pull picker itself is built for big time corn farming — big ears, big fields, big yields. Low reaching gathering chains get more down corn. High capacity husking bed husks cleanest through heaviest corn.

Deal now using NEW IDEA's own low cost finance plan. Only $600 down for NEW IDEA picker with One Shot system — only $560 down for picker with banks of fittings for fastest hand lubrication. See your NEW IDEA dealer. Or mail coupon today for free literature!

NEW IDEA
PRODUCTS OF AVCO CORPORATION

NEW IDEA Box 304, Coldwater, Ohio

Please send free literature on picker(s) checked and NEW IDEA Facts on Financing folder.

☐ 2-row pull picker with and without One Shot lubrication system
☐ 2-row mounted picker ☐ 1-row pull picker

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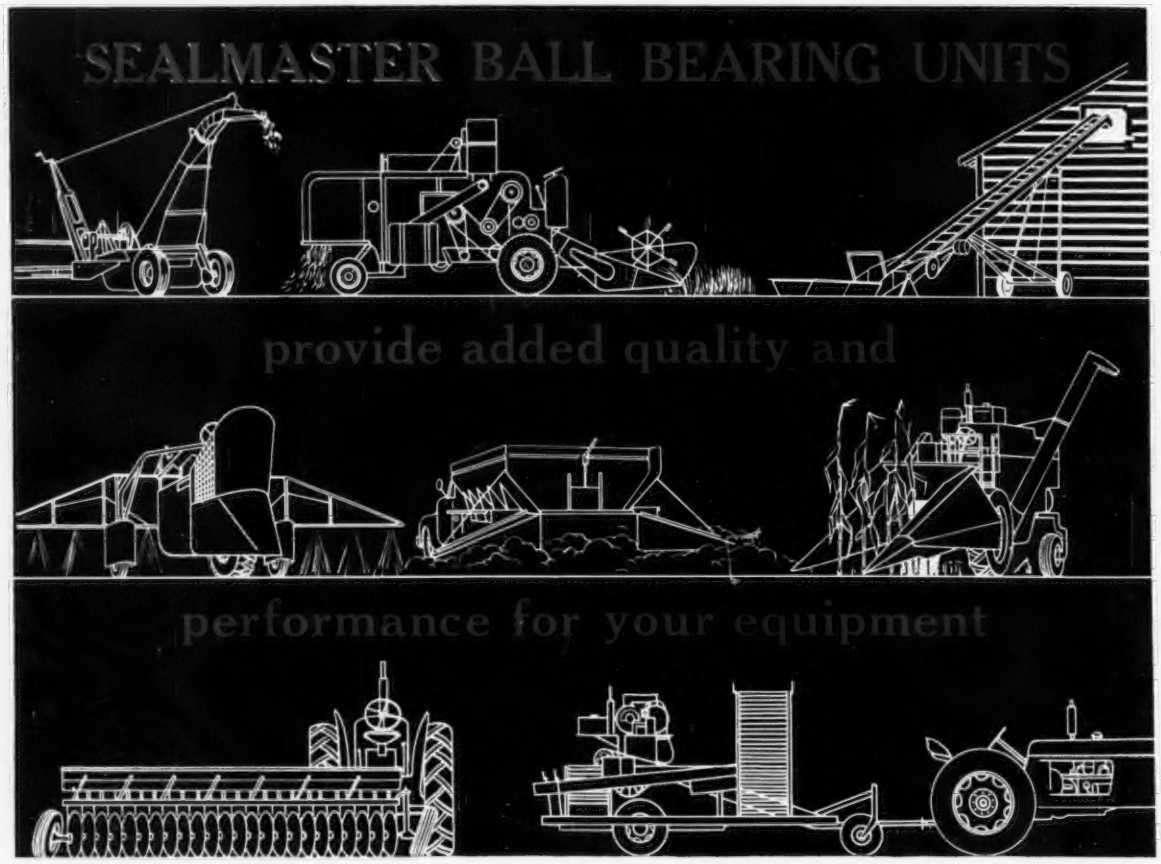

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Pulls wider hitches of tools, 6-9 plow bottoms depending on soil conditions.
NOW DEMONSTRATING... AT YOUR CATERPILLAR DEALER
Lifetime lubricated rollers and idlers—need no servicing until rebuilt. Forward-reverse lever for fast reversing.
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Caterpillar's New D4C 65 HP Tractor

13,000 lb. drawbar pull (about twice as much pull as most 4-5 bottom wheel tractors) • 5 speeds forward, 4 reverse—25% more lugging ability than ever.

Ask the man who farms with a Cat Diesel Tractor. Ask your conservation contractor about crawlers. Men who make their living doing the toughest jobs—earthmoving, land clearing, heavy-duty custom work—pick Caterpillar Diesel Tractors.

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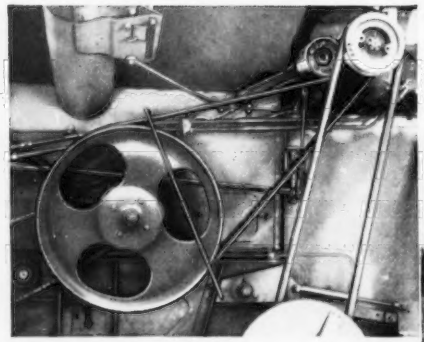

Close-up of Deere unit shows Condor Flat Whipcord Belt on a separator drive and two Manhattan Agricultural Traction Drive V-Belts transmitting power from engine to wheels through a variable speed sheave.

On job-proven farm equipment like the John Deere 95 Combine pictured above, Manhattan Agricultural Belts assure positive power delivery and long service life where it counts the most—in field operation.

Manhattan belting engineers draw on more than 60 years of rubber technology and experience to produce the most reliable and economical belts available today. The exclusive Extensible-Tip Splice on Condor Whipcord Belts, for example, is a feature found in no other endless farm belt. Other engineered features of strength, flexibility and long service life built into Condor Whipcord Belts and Manhattan Agricultural V-Belts contribute to the success of farm equipment by making power drives as trouble-free as possible.

Let R/M show you why Manhattan Agricultural Belts have won the confidence of leading farm machine manufacturers . . . how they can add "More Use per Dollar" to the equipment you design or produce.

ENGINEERED FOR FARM EQUIPMENT DRIVES

• MANHATTAN AGRICULTURAL V-BELTS • CONDOR WHIPCORD ENDLESS BELTS

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RM1000

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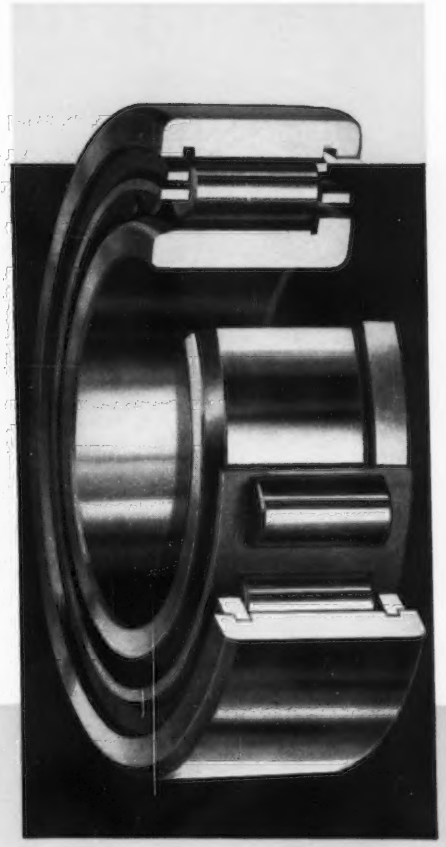
ENGINEERED RUBBER PRODUCTS ..."MORE USE PER DOLLAR"

Aetna
ROLLER BEARINGS



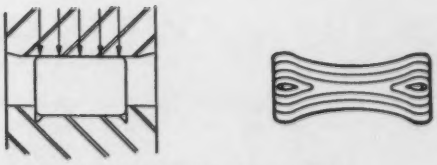
True Crowned for 15% longer service life

Because each Aetna roller is *True Crowned* with a large radius, high stress points in the rollers are relieved—giving 15% longer bearing life. The crown radius is scientifically determined and varies with the roller size.

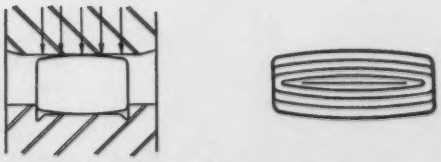
Aetna offers a wide range of self-contained *True Crowned* pure radial roller bearings in both custom and standard designs—also many special designs of both pure radial and pure thrust bearings for unusual applications.

For complete information on *True Crowned* Aetna Roller Bearings, call your Aetna representative listed in your classified telephone directory, or write for General Catalog and Engineering Manual.

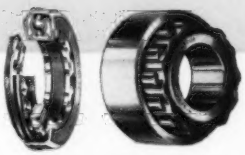
True Crowning as produced by Aetna.



Straight roller showing stress pattern at roller to race contact.



True Crowned roller showing stress pattern at roller to race contact.



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DIVISION OF PARKERSBURG-AETNA CORPORATION

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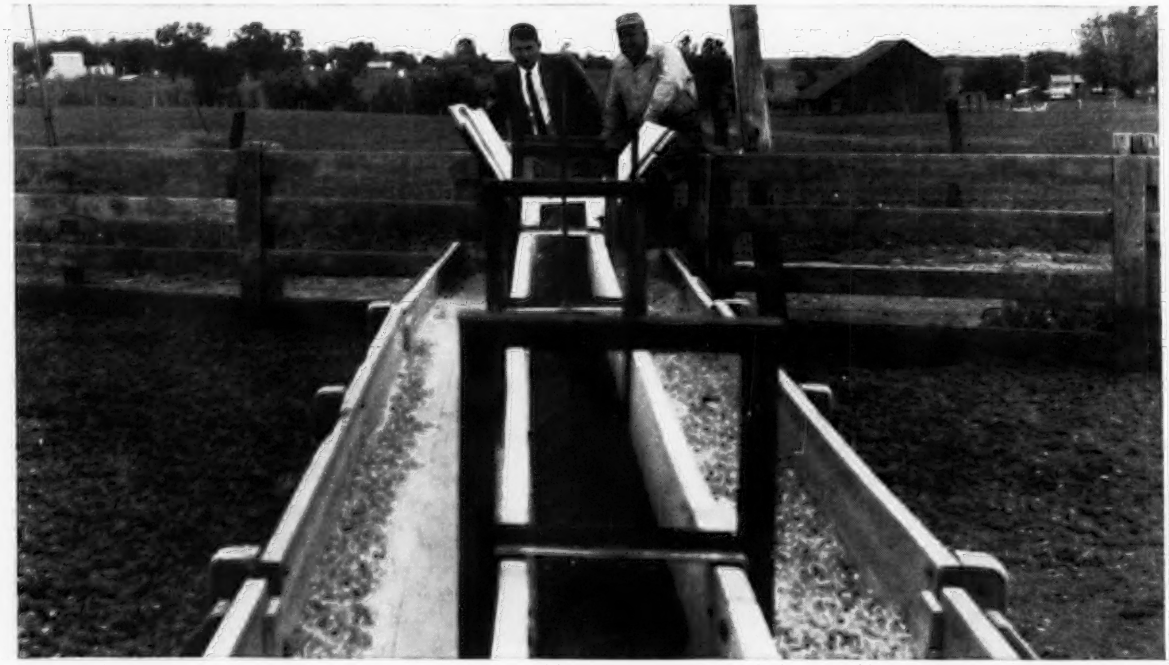
HOME-MADE CATTLE FEEDER SAVES TIME AND MONEY

Roy Spencer (right), who farms more than 400 acres near Downs, Ill., built the automatic auger feeder shown, at a cost of about $70. Feed is dumped in at the end and is distributed in the feeding troughs by the auger. An old car transmission gives the auger variable speeds, including reverse. Mr. Spencer is able to feed 40 head of cattle at a time and save labor — which means *money*. Texaco Representative Frank Dwyer is shown at left.

Roy lubricates his farm machinery with Texaco Marfak because it sticks to bearings better and longer. It forms a collar around open bearings, sealing out grit and dirt. Marfak won't jar off, wash off, melt down and drip out, dry out or cake up. It cushions bearings, adding life to farm machinery.

Get in touch with your Texaco Distributor and order some Marfak today. You'll find *it pays to farm with Texaco products.*



Another inventive farmer votes Texaco!

Jerry Pfister, farm manager of the Pfister Hybrid Seed Corn Co., El Paso, Ill., which grows some 240,000 bushels of corn annually on 4,600 acres, finds labor savers worthwhile. One of his father's ideas was putting plank cleats on a tractor, as shown in photograph, to keep the tractor from packing the soil. Another idea was hitching three corn planters together so that one man can plant twelve rows of corn in one operation. Jerry finds Texaco products best for farm machinery. He prefers Advanced Custom-Made Havoline Motor Oil, for example, because it cleans as it lubricates, giving longer engine life.

Mr. Pfister gets his petroleum products from Texaco Distributor Milo Sterritt, of Minonk, Ill. In this photograph, Jerry (right) is talking with Texaco District Manager B. G. Ansorge. Like farmers across the nation, Mr. Pfister agrees that *it pays to farm with Texaco products.*

BUY THE BEST... BUY TEXACO

TUNE IN: TEXACO HUNTLEY-BRINKLEY REPORT, MONDAY THROUGH FRIDAY, NBC-TV

New
Allis-Chalmers Rake
is equipped with

BLOOD BROTHERS

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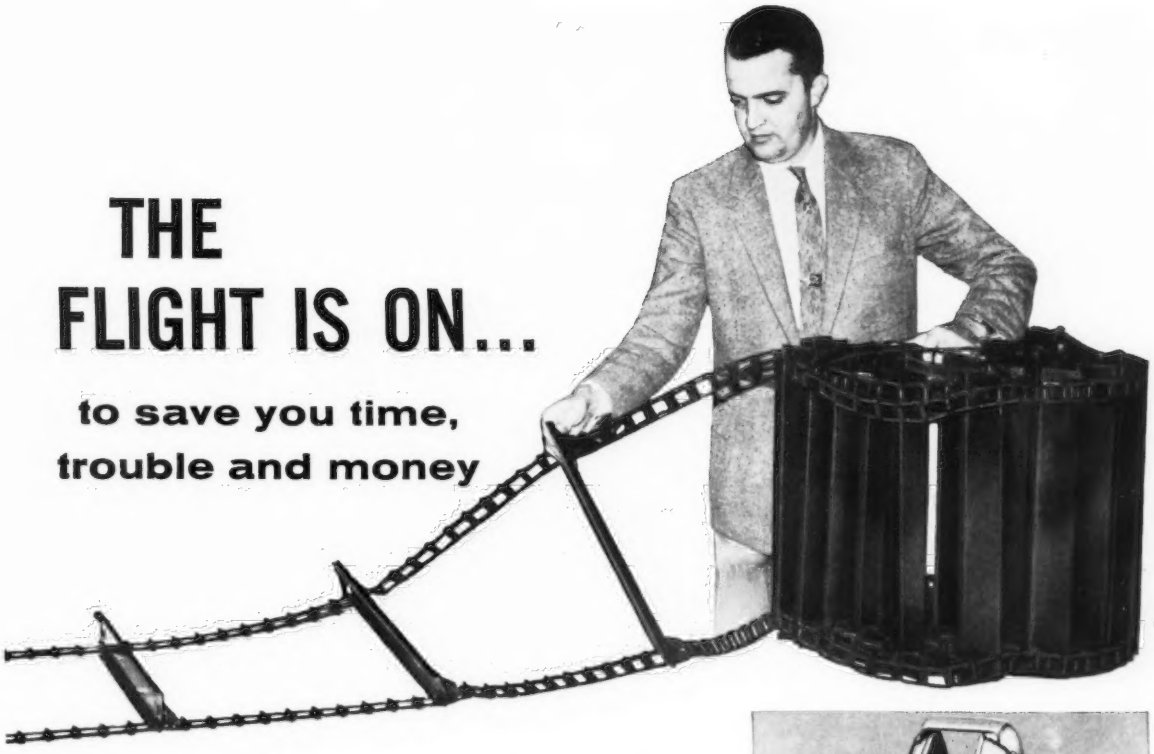

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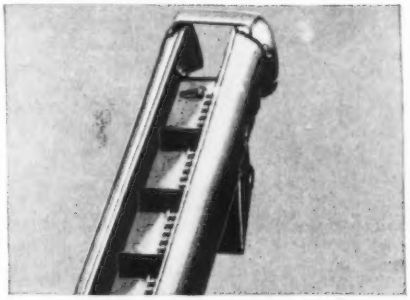

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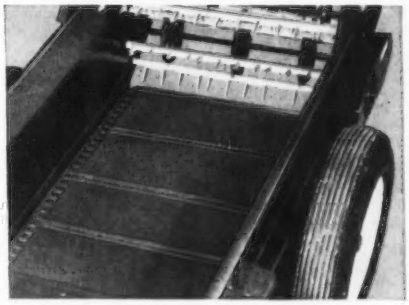

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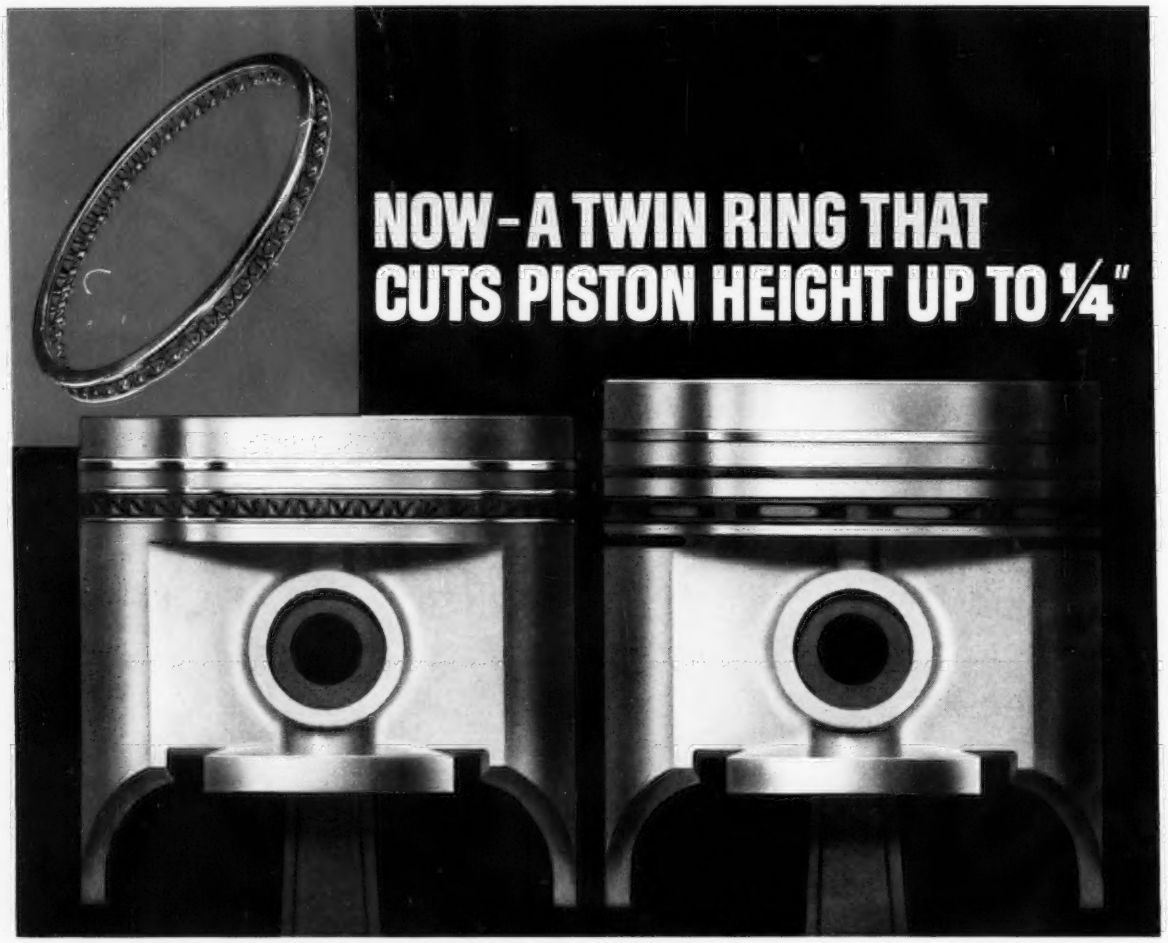

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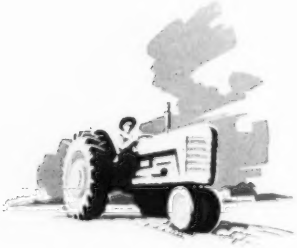

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Agricultural Engineering

June 1960
Number 6
Volume 41

James Basselman, *Editor*

Conference Features Confinement Housing of Livestock

DURING the past few months excitement and interest have been high in preparation for the ASAE 53rd Annual Meeting at Ohio State University, June 12 to 16. By the time this issue reaches most of its readers that meeting will be over and plans for the summer will demand top priority. ASAE Sections will be pointing for their first meetings in the fall, the first on our meeting calendar being the North Atlantic Section meeting August 21 to 24, and the next national meeting normally is the Winter Meeting to be held this year in Memphis, Tenn., December 5 to 7. However, this year a special Farmstead Engineering Conference on Confinement Housing of Livestock is being sponsored by ASAE Farm Structures Division, in cooperation with the Agricultural Engineering Research Division, ARS, USDA, and departments of Agricultural Engineering and University Extension, University of Illinois, and will be held at University of Illinois, Urbana, September 13 to 15.

The Committee for Farmstead Engineering Conference, E. L. Hansen, (chairman), E. D. Anderson, S. S. DeForest, C. F. Kelly, C. W. Hall, M. W. Forth, and K. H. Beauchamp, has arranged an outstanding program for the special conference, the second of its kind sponsored by the Society, since it sponsored the Farm Materials Handling Conference in September 1958.

The purpose of the farmstead engineering conference is to collect and disseminate the most current information on all factors affecting confinement housing of livestock and to summarize and bring into focus basic and functional design requirements relating to engineered farmstead and housing systems. Its objectives are: (a) To present the most advanced information from the standpoint of management, breeding, feeding, sanitation, marketing, and other future considerations which may affect farmstead engineering; (b) to present basic and functional requirements of animals in a way that is useful to designers; (c) to present design procedures and solutions for combinations of components for economical operation; (d) to point up areas in which basic research is needed; (e) to focus attention on cost vs. returns of engineering housing systems; (f) to focus attention on power requirements of engineered farmsteads; and (g) to publish this material in a special issue of the Journal for easy reference.

One-half day sessions will be devoted to each of the following: Poultry, swine, dairy, and beef. One evening session will be devoted to cost vs. returns from engineered farmsteads, and meeting capital requirements for engineered farmsteads. The second evening will consist of a dinner meeting in which future farmstead power requirements, and from where will the power come, will be discussed. On the afternoon of the third day, a tour of research installations is being planned.

The opening session will be held on Tuesday afternoon, September 13, and will be devoted to a poultry program. T. C. Byerly, deputy administrator, Agricultural Research Service, USDA, will give the keynote address, and discussions on the functional and basic requirements of poultry housing, by A. D. Longhouse, H. Ota and M. L. Esmay, will follow. Combination of components for economical operation for poultry will be discussed by F. P. Stephan, L. N. Drury, and Denver O. Baxter. A Tuesday evening session will cover the topics of cost versus returns from engineered farmsteads, by Roy N. Van Arsdall and Velmar Davis, USDA agricultural economists; and meeting capital requirements for engineered farmsteads, by Douglas F. Graves, assistant vice-president of Chicago National Bank.

O. Burr Ross, head, animal science department, University of Illinois, will give the keynote address at the Wednesday morning program, which will be devoted to swine. The program will consist of talks by T. E. Hazen on the functional and basic requirements of swine housing; and combination of components for economical operation, by D. G. Jedele. The session on Wednesday afternoon, at which Woodrow Snyder, department of dairy, Michigan State University, will deliver the keynote address, will be devoted to dairy. R. E. Stewart and S. A. Witzel will discuss the functional and basic requirements of dairy housing, and the combination of components for economical operation will be covered by J. T. Clayton and Thayer Cleaver. The Wednesday sessions will be concluded with a 6:00 p.m. dinner meeting at which Herbert N. Stapleton, agricultural engineer, Shelburne Farms, will speak on the future farmstead power requirements, and Virgil Herriott, general manager, Sioux Valley Empire Electric Assn., Inc., will speak on "From Where Will the Power Come?"

A beef program is scheduled for Thursday morning, when A. E. Darlow, vice-president, agricultural sciences, Oklahoma State University, will give the keynote address. C. F. Kelly and A. H. Schulz will discuss the functional and basic requirements of beef housing. The subjects of combination of components for economical operation, by N. H. Curry, and let's dream — the farmstead of the future, by H. J. Barre, will also be included on this program. A tour of research installations on Thursday afternoon will conclude the three-day conference.

The September issue of AGRICULTURAL ENGINEERING will be devoted entirely to farmstead engineering and by reason of the scope of the material it will contain, including all papers presented at the Conference, promises to be a comprehensive handbook on the subject, suitable for the engineer, manufacturer, dealer, and farmer alike.

ASAE Winter Meeting • Peabody Hotel, Memphis, Tennessee • December 5-7, 1960

PRODUCTION OF Hay Wafers

John B. Dobie
Member ASAE

A review of progress in developing wafer-making equipment

THE production of hay wafers has progressed to the point of realization in fewer than five years of intensive research. Most wafering machines are still experimental, but experience with the equipment and the product is sufficient to permit a critical appraisal of what has been accomplished thus far.

Present progress can be evaluated largely in terms of the principal objectives — a hay package that provides *(a)* good bulk-handling characteristics, *(b)* reduced storage space, *(c)* minimum waste, *(d)* optimum feeding results, and *(e)* reduced handling costs.

Fundamental Studies

The work of Bruhn (1)*, Butler and McColly (2), and Pickard *et al* (3) on the fundamental factors affecting the making of hay wafers has formed the basis for much of the machine development that has taken place. To augment this information, prospective manufacturers have performed laboratory tests of a fundamental or exploratory nature. A study of available reports indicates a few basic considerations for the design of hay-wafering machines:

(a) For suitable density and stability of the wafer, the pressure applied should be about 5000 psi.

(b) Holding hay at maximum pressure for a longer time reduces the pressure required for suitable wafer density and stability.

(c) The shape of a wafer affects its density and handling characteristics. The optimum length-to-diameter ratio is 1.0.

(d) Small amounts of binding materials are ineffective with long or chopped hay.

(e) The optimum range of hay moisture content is 15 to 25 percent.

Machine Development

Numerous hay-wafering machines are now at various stages of development. Some are still in the laboratory stage, several have undergone some field testing, and one is now available commercially. Public knowledge of these machines increases with their stage of development.

Current models of wafering machines are of three basic designs, as shown in Fig. 1: *(a)* reciprocating or plunger, *(b)* roller, and *(c)* screw. The reciprocating machine operates on the same principle as most balers, except that the plunger and compression chamber are so designed as to provide the increased pressure necessary to produce a wafer. The hay is extruded through a die which can be adjustable to control resistance to passage of hay. The die can be square or round, of single or multiple hole design.

Roller-type waferers use the continuous-flow principle, gradually compressing a windrow of hay into an area of 2 to 6 sq in. It is not an extrusion process but does necessitate cutting the ribbon of hay after or during compression.

The screw-type waferer also provides continuous flow, but may develop excessive friction during compression. Screw waferers extrude the hay through a die, and require some device to break the extruded hay into a suitable length.

The waferer that is commercially available is a stationary model operating on the reciprocating-plunger principle. The two plungers, operating alternately, produce wafers 4 in. in diameter, and about one inch thick from chopped hay or coarsely ground hay. Several of these machines, producing 3 to 5 tons per hour, are in use on the West Coast. A splitter may be used for cutting the wafers into a half-moon shape. This machine is usually powered with a 100-hp electric motor, thus using about 25 hp per ton per hour output. Maximum particle size must be about that of a ¾-in. theoretical length of cut to feed into the compression chambers without bridging. When producing wafers from coarsely ground hay, bulk density of these wafers approaches 30 lb per cut ft. Wafers made from chopped hay may be slightly less dense. Die liner wear has been a problem, particularly when the hay includes excessive dirt.

Wafer Configuration. Wafer size and shape are an integral part of machine design. Plunger and screw waferers extrude the hay through a die; hence the cross-sectional dimensions depend on die design. In a roller-type machine, the width of the rolls and the cutoff method control the fixed dimensions of the wafer. Thickness of the wafer varies with the rate at which hay is fed into the machine, which in turn depends on windrow size and ground speed. From the standpoint of machine design, maximum wafer size is limited by total pressure, which must be kept within the allowable limits of loading of bearings and other machine parts. Increasing the fixed dimensions of the wafer provides greater capacity, which is the principal advantage of large sizes.

Other things being equal, small wafers nearly cubic in shape are best for handling and storage. They flow better, handle easier mechanically, and have greater bulk density than large, flat wafers. They can be eaten whole by cattle, thereby reducing the amount of trash produced during feeding. The smaller sizes more nearly fulfill the objectives of hay wafering. Nevertheless most experimental models are producing relatively large wafers.

Dwell Time. Laboratory tests indicate that, to obtain wafers that will retain their compressed form with a minimum of springback, pressure should be maintained on the hay for 5 to 10 sec. Plunger-type waferers, operating at speeds up to 400 rpm to obtain suitable capacity, apply full

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged jointly by the Power and Machinery and the Electric Power and Processing Divisions.

The author — JOHN B. DOBIE — is specialist in agricultural engineering, University of California, Davis.

*Numbers in parentheses refer to the appended references.

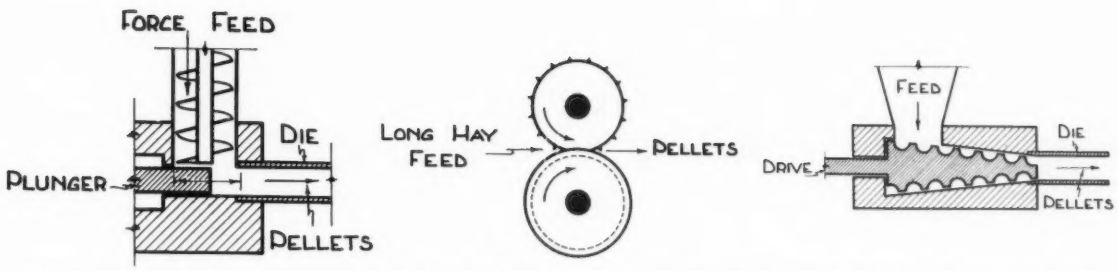

Fig. 1 Schematic diagrams of compression devices for *(left)* plunger-type, *(middle)* roller-type, and *(right)* screw-type hay waferers

pressure for less than 1/25-sec for each stroke. Pressure is applied repeatedly during the time the hay is in the die, with some springback between strokes. At this high speed, much of the compressing effect is the result of impact, which may partially replace the need for extended dwell time.

Roll-type waferers provide dwell time of about ½ sec when producing 3 tons per hour. Pressure is applied gradually, with little or no impact effect. Optimum hay condition is necessary to produce wafers of suitable density and durability.

Continuous-pressure devices, extruding hay through a die, as does the screw, provide the greatest dwell time and consequently should develop adequate density at minimum pressure. Even there, producing a wafer of 4-in. diameter at 3 tons per hour would require a 28-in. long die for 5 sec of dwell time. Dwell time requirements are not compatible with adequate machine capacity.

Feeding Mechanism. Feeding long hay into a restricted space prior to compressing is a major design problem with all machines. Some degree of precompression is necessary if operation is to be smooth and continuous. The problem is least complicated on continuous-flow machines, such as rollers and screws, but even there special equipment is required to prevent wrapping and feed-back as the hay enters the precompression stage. The problem becomes more complicated with plunger machines, where a steady incoming stream of hay must be fed into a high-speed intermittent compression device. As capacity is increased, the problems in the force-feed mechanism become more acute, particularly if the stream of hay must be divided between multiple compression devices.

Power Requirement. Laboratory tests usually indicate that actual power requirements are relatively low, yet current models of field machines, regardless of type of compression device, seem to require an engine rated at a capacity of 30 to 40 hp per ton per hour. Not all of this power is required continuously, but it must be available to handle special situations that arise in the highly variable field conditions. Excessive wear and breakage in experimental models indicate a need to design for a greater safety factor and greater loads than anticipated.

Capacity of Waferers. The capacity of current experimental models is quite variable and is not necessarily indicative of the potential of the particular piece of equipment. There is a tendency to feel that a machine that will successfully produce two or three tons per hour can be doubled in capacity by doubling its operating speed or, alternatively, the size or number of the compression device. Experience has shown that other factors, such as feeding mechanisms, wafer springback, and variations in field conditions, also

Fig. 2 A stationary hay-wafering plant

Fig. 3 A pile of field-made hay wafers (Note the slope of the pile and the collection of trash under the conveyor. The pile of wafers in the foreground was dumped from a forage wagon)

increase in importance, requiring major design changes to compensate for the increased flow of hay. Hay waferers necessarily produce high pressures, and the additional stresses caused by greater capacity have caused unexpected mechanical failures.

The capacity that will be required of a successful field waferer will probably vary with geographic area. To handle the crop satisfactorily, daily capacity in a range similar to that of balers will be desirable. The length of day suitable for operation as well as the hourly capacity of the waferer is important. In some areas, 4 tons per hour may be ample. Few of the large hay growers in California would be satisfied for long with less than 6 tons per hour.

Weight of Machine. Weight has been an important consideration in the design of most of the experimental models. It is particularly important in a perennial crop such as alfalfa, because resulting compaction continues for several years before deep tillage partially disrupts the cumulative effect. Designers must consider sprout damage to the next crop, and hence cannot widen treads unnecessarily. Weights of present models vary from about 2½ tons upward. Most current models are not excessively heavy compared to other equipment used in hay fields, but this problem will be of more concern as the machines increase in size to provide greater capacity.

Auxiliary Equipment. Most field waferers convey the finished product into a wagon trailer. Some of the conveyors damage the wafers considerably, creating excessive trash. Too little attention has been given to this necessary part of the machine. In most field machines, the wafers are ejected to the front, requiring a change of direction as they are conveyed to a rear-trailing wagon. Redesign to permit direct flow out of the rear of the waferer into the wagon should alleviate this problem. Available equipment is often unsatisfactory for handling wafers from the machine to storage, and on to the animal. More emphasis will need to be given to the development of a complete handling system.

Other Design Problems. Die design is important. As in the case of pelleting, die replacement will be a major repair item unless special emphasis is placed on the materials used and the development of inexpensive liners to reduce the cost of replacement. Roller wear may also be a major item for this type of machine. This problem will be greater in field operation than in stationary installations, where abrasion from sand and dirt is already of real concern in processing hay.

Testing of Field Waferers

One or more versions of each of the basic types of hay waferers have undergone some testing as field machines. The results have encouraged most prospective manufacturers to continue their efforts; a few have curtailed active research in hay wafering. There are apparent advantages in moving hay wafering to the field, but it should be recognized that this increases the number and severity of variables that affect the wafering process. In any one field, some of the variable factors that may affect operation are: *(a)* moisture content of the hay, *(b)* uniformity of moisture content, *(c)* climate, *(d)* size and uniformity of the windrow, *(e)* quality of the hay (including stage of maturity, weeds, insect damage, disease), *(f)* kind of hay (legume, grass, mixture), and *(g)* foreign materials. Differences between geographic areas may be even greater. Field waferers should be capable of operating satisfactorily under widely varying conditions.

Moisture Content. Most machines operate reasonably well with an average moisture content up to 25 percent if the moisture level is relatively uniform. That is seldom the case in the field, however. Moisture variation amounting to 30 percent has been noted in a given field, sometimes within a few feet of windrow. Field wafering may necessitate improved mowing and windrowing management to overcome such variation. The alternative is overcuring before wafering, which increases the weather hazard in some areas and the leaf shatter problem in others.

Climatic Conditions. Haymaking practice varies widely with local climate. In humid areas, once the hay has been field-cured to a satisfactory moisture content, wafering may be done during the driest part of the day. In other areas, including much of California, minimizing leaf loss requires that hay should be harvested only during periods of high humidity or when it is tough with dew. This type of operation is particularly difficult for field waferers since the period of optimum harvesting condition is relatively short, necessitating high-capacity machines to handle appreciable acreages. Artificial moisture application on the windrow, either at the pickup or well ahead of the machine, has been used as a means of lengthening the period of satisfactory operating conditions.

Size and Uniformity of Windrow. Variations in windrow size and uniformity affect the operation of field waferers. Two 7-ft swaths rolled together to form a loose, uniform windrow are best for most machines. Uneven windrows, besides contributing to large moisture variations, are difficult to feed at a steady rate into the precompression unit and may cause overloading in the wafering chamber. On most machines, automatic pressure-regulating equipment has inadequate range and is too slow-acting to compensate for major or sudden variations. Roller-type waferers are particularly susceptible to large fluctuations in windrow size. Too little hay causes excessive trash; too much hay will not pass the rollers except at reduced pressure, resulting in low-density uncut wafers. Chopping prior to wafering would overcome most problems of windrow size and uniformity, but would involve an additional operation.

Quality and Kind of Hay. Legume-type hay makes the best wafers. Most machines will not produce a satisfactory wafer from grass hay. Grass-legume mixtures can be wafered if the legume is a major portion of the mixture. Leaf-to-stem ratio, stage of maturity, insect damage, and weed or grass content all have an effect on wafer quality. Wafer quality varies directly with the amount of leaf in the hay. Leaves help to bind the stems together, with less springback. This is shown by a recent experiment at the University of California at Davis, in which hay was purposely mishandled to reduce leaf content in varying amounts, by raking or by wafering when dry, or by both. Optimum conditions consisted of performing these operations in the

TABLE 1. PROPORTION OF TRASH IN WAFERS

Treatment	Percent of Trash by Weight
Raked and wafered when tough	15.1
Raked dry, wafered when tough	18.7
Raked when tough, wafered dry	46.1
Raked and wafered dry	65.9

morning while the hay was tough with dew. Table 1 shows the proportion of trash resulting from the various treatments.

For this experiment, the best conditions produced only 85 percent good wafers. Raking when dry increased the amount of trash from 15.1 to 18.7 percent. Wafering when dry produced only 54 percent good wafers, and this condition was further aggravated when the hay was also raked dry. Leaf loss due to raking when dry amounted to 25 to 30 percent of the total yield, by weight, thus reducing the leaf-to-stem ratio appreciably.

Foreign Materials. Foreign materials in hay, such as wire, cans, machine parts, rocks, or clods have more effect on wafering than on baling. Tramp iron may be cut into pieces of such size as to cause hardware disease if ingested by cattle. This situation already exists, particularly with chopped hay, but the problem may increase if wafers replace baled hay.

Machine parts and rocks have caused comparatively little mechanical difficulty with field waferers. One-half-inch steel rods or bolts have passed through the compression chamber with little or no damage to the machine. Clods of dirt are the most serious problem. In damp ground, particularly when turning at the end of the windrow, a sizeable clod will occasionally be raked up with the hay and may be carried into the machine. When such an object reaches the compression chamber intact, the waferer usually stalls, often so suddenly that some part of the machine fails. A solid mass of earth is non-compressible and will not pass through a die smaller than the cross-sectional area of the clod. Elimination of clods is essential to the reduction of major mechanical failures in field waferers.

Progress Toward Objectives of Hay Wafering

Experience gained through tests and observations has been sufficient for consideration of the improvements in hay making and hay handling that may result from wafering. Such comparisons should be made with bales and with ground-hay pellets since it appears that wafers may have to compete with both.

Bulk Handling. The angle of repose of pellets varies from 25 to 35 deg, compared to about 45 deg for most wafers. Pellets will flow to their angle of repose when part of the pile is moved; most wafers will not flow unless disturbed mechanically. Flowability increases as the length-to-diameter ratio approaches unity. In the larger sizes, however, bridging so limits the flow from closed bins that mechanical aids are required to remove wafers from storage. Pelleted hay is an ideal form for bulk handling, because of density and optimum flow characteristics. Wafered hay lacks the flow characteristics of pellets, but can be handled much more readily than baled hay and should reduce the labor of handling appreciably.

Wafer Density. The density of the wafers produced by field machines varies with field conditions and is often unsatisfactory. For good handling and storage characteristics, wafers should have a bulk density of 25 lb per cu ft or more. This is also a minimum density for reducing domestic and overseas transportation costs. Random samples of field-made wafers, taken from storage, range in bulk density from 10 to 28 lb per cu ft, usually less than 20. The bulk density of the wafers produced by some experimental machines is little better than that of baled hay.

Feeding Results. Pelleted hay has set a precedent in increased feed consumption and rate of gain for meat animals that wafered hay has failed to match. Consumption of wafered hay is comparable to that of baled hay, except that waste may be less with wafers. Waste in feeding wafers is largely the result of fines or trash in the feeder. More wafers are torn apart than are consumed. When wafered hay is kept before animals continuously, they tend to reject the trash in favor of fresh wafers. This selection can be reduced by controlled feeding.

Wafering does not disguise poor quality hay as much as does grinding and pelleting. From an acceptability standpoint, hay quality may be more important with wafers than with pellets.

Wafered hay has shown good results with dairy cattle, and unlike pelleted hay, it has not been associated with a reduction in butterfat content of the milk. Of three dairies using wafered hay exclusively, all report satisfaction with the feeding results.

Reduced Handling Cost. Wafers have obvious bulk-handling advantages over bales, but density will have to be improved considerably before wafers will show any reduction in transportation costs for commerical hay. Baled hay requires excessive labor for loading and unloading, but can be piled high enough to provide a near-maximum payload. Pelleted hay, with its high density and excellent flow factor, can be shipped in bulk-grain trucks with completely mechanized loading and unloading, whereas wafered hay cannot be handled satisfactorily with present trucking equipment. If wafered hay is to become an important factor in commercial hay, a new type of hauling unit must be developed, incorporating high sideboards and mechanized or gravity unloading. This will be a special piece of equipment, poorly suited to other major transport requirements.

Wafers are readily loaded, moved, and unloaded with flight conveyors, tractor-mounted scoops, and similar equipment. Handling before and after transport should result in appreciable labor saving. Lack of sufficient wafers has hampered the development and testing of practical handling systems.

Summary

There has been considerable progress in the development of hay-wafering equipment, but experience indicates numerous machine design problems and some inadequacies of the product. The wafers lack many of the density and handling characteristics desired to make the change to bulk handling for hay. Machine capacity is inadequate for most farms, and conditions suitable for field operation are too limited to permit reasonable annual production per machine. Machinery for handling wafers from field to storage and for transporting wafers has been improvised from existing equipment rather than developed as a system. Obviously, there is much to be done before field wafering will be an important factor in hay harvesting.

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Molded Fiber Glass in Farm Equipment

D. E. Brail
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Possible applications for improved performance and service life

THOUGH there are other types of reinforced plastics, this paper will be limited to the type which is reinforced with either glass mat or preform and uses a thermosetting polyester resin.

The polyester resin used is a liquid about the color and consistency of honey and costs about 30 cents per pound. To the resin is added a clay or calcium carbonate filler. Filler costs only 1 or 2 cents a pound; it not only helps cut the cost but also helps to control crazing or surface cracking, shrinkage, and warp, and certain kinds act as fire retarders. To this mix, pigment can be added to get any desired color if the parts are not to be painted. Just before the mix is to be used, the catalyst or hardener is added. The catalyst for matched metal-die molding is normally benzol peroxide.

A number of different kinds of glass mat are used, costing from 50 to 75 cents per pound. Generally speaking, mat would be used on parts which have relatively little compound curvature. The result of using glass mat on a compound curvature would be the same as trying to wrap a sheet of paper around a sharp table corner. That is, at the point of the corner the paper would pull tight and rip and down the sides it would wrinkle badly.

To make a preform, rovings or a rope of many small glass filaments are used which cost about 40 cents per pound. A preform is made by fabricating a perforated metal screen to the exact contour of the part to be produced, and mounting this screen in a special preform machine where an exhaust fan pulls air through the screen at a high static pressure. The roving is chopped into 2-in. lengths in a specially designed cutter and deposited against the preform screen along with an emulsion of polyester resin as a binder. The binder is cured by circulating heated air through the part, and a formed glass mat or "preform" can then be lifted from the screen. The preform is then placed over the die, the catalyzed resin is spread over the preform, the press is closed, and in two to four minutes, depending on the size and temperature used, a molded part has been formed.

The proportion of fiber glass reinforcement in molded parts can be varied from 15 to 50 percent by weight. Physical properties increase with an increase in glass content, but this also increases the cost. When more than 35 to 40 percent glass is used, there will be a prominent fiber pattern on the surface of the part. This may be objectionable in appearance parts and can be eliminated by using a fine texture veil surfacing mat, or through use of special primer paint.

In the manufacturing process, the molded fiber glass companies use matched metal dies in hydraulic presses. These dies are steel plate for parts no deeper than 6 in. or alloy iron castings for deeper parts. Both have flame-hardened telescoping pinchoffs and are heated with steam to temperatures ranging from 215 to 275 deg. The hydraulic presses exert pressures of 100 to 150 psi on the molded part.

There are other processes of molding fiber glass, the main ones being hand lay-up and vacuum molding. Both of these methods have a low tooling cost and are quite high in price per piece. Therefore, they are used on low-volume jobs when tooling costs would prohibit matched metal dies. Matched metal dies have the following advantages: *(a)* highest and most consistent physical properties, *(b)* closest control over material thickness, *(c)* a smooth surface on both sides of the part, *(d)* highest possible production rate, and *(e)* lowest unit cost.

Fiber-glass reinforced plastic panels are generally used in place of parts which could be made of sheet metal. Tool cost and tool time are much less than for sheet metal if parts have compound curvature. It is practical to make large deep-draw parts instead of assemblies of smaller parts. In addition fiber glass may be selected for one of the following reasons:

Weight Savings. This may not be considered important in farm machinery. Molded fiber glass 0.1 in. thick is used to replace 20 gage steel in automotive applications. It is three times thicker but about 40 percent lighter. A saving in weight allows more payload or results in increased performance for a truck cab, and it would perhaps be just as important in some agricultural applications.

Corrosion Resistance. This is important in farm machinery. Molded fiber glass has excellent acid and solvent chemical resistance and will withstand mild alkalis. High heat distortion resins have good chemical resistance up to 200 F, and all resins have best chemical resistance at lower temperature.

Sound Deadening. The use of continuous bonded joints cuts much of the noise associated with metal assemblies. Molded fiber glass is a non-resonant material.

Permanent Molded in Color. If an automotive-type finish is not required, color can be molded in the parts.

High Impact Resistance. The impact resistance and elasticity of a fiber-glass reinforced part will reduce considerably minor damage dents that are prevalent in metal parts.

Ease of Repair. When a fiber-glass reinforced part is damaged, it can be repaired easily with a minimum of equipment by relatively inexperienced personnel. It is easier to repair than wood or metal parts.

Translucency. In the case of a fertilizer hopper the level of the material inside can be seen through the side-walls.

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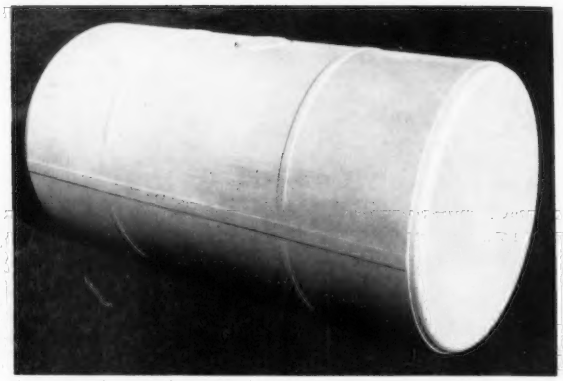

Fig. 1 Farm equipment uses for molded fiber glass include *(left)* a 200-gal spray/storage tank and Fig. 2 *(below)* a 24-in. fertilizer hopper

Low Coefficient of Heat Transfer. Thermal conductivity is low, resulting in a better retention of heat in cold weather and less absorption of heat in hot weather.

There are certain design considerations that should be taken into account when planning on a fiber-glass part, such as the following:

Minimum Inside Radius (⅛ in.). Sharp corners should be avoided whenever possible. The larger the radius, the better the appearance will be.

Thickness Variation. Because of the difficulty in locating the fiber-glass reinforcement accurately, parts with varying wall thickness should be avoided. Shrink lines will show up where thickness varies.

Undercuts. These should be eliminated inasmuch as they cannot be molded. Molded fiber glass can be flanged out instead of in, or an extra part can be bonded.

Molded-in Holes. Holes can be molded in only on horizontal surfaces.

Minimum Draft. All parts must have draft. The minimum is 2 degrees, but 3 to 5 degrees is recommended.

Minimum and Maximum Thickness. For custom molding the minimum recommended thickness is 0.05 in. and maximum thickness is 0.25 in. For flat sheet the minimum is 0.03 in. and the maximum is 0.50 in.

Maximum Size. With the new presses now available, shapes can be molded up to 20 ft long, 8 ft wide, and 3 ft deep.

Molded Fiber Glass in Agricultural Applications

In the case of agricultural equipment, certain requirements are imposed on materials of manufacture which are uniquely fulfilled in fiber-glass reinforced plastic, but generally no great interest has been aroused in the industry in what these materials might offer in terms of longer life and superior performance.

At present there are only a few accepted applications. One of these is a high-production dry fertilizer hopper which has been out for years. Although its cost is higher than a metal hopper, it has had wide acceptance. Our com-

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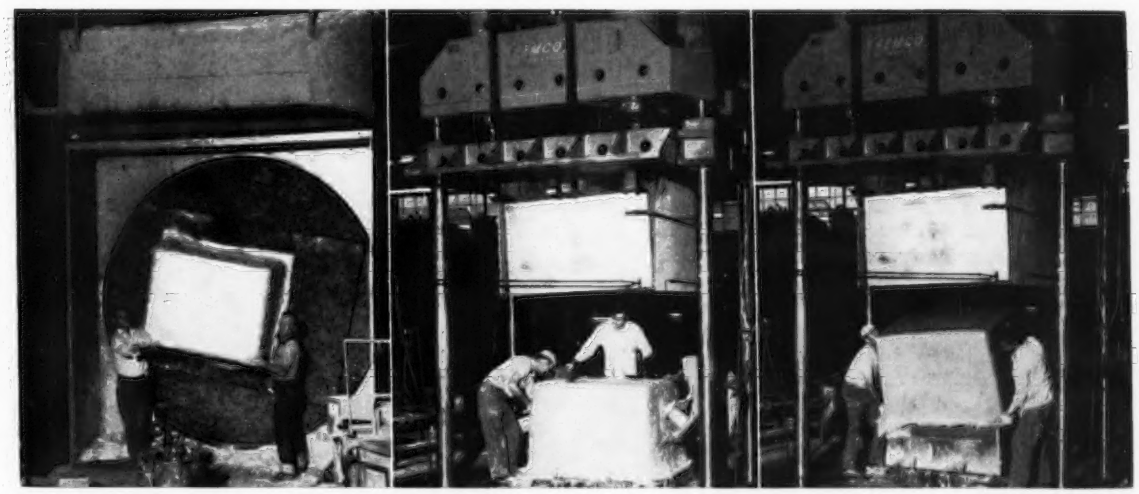

Fig. 3 Production operations of molded fiber glass moldings include *(left)* removing preform from press *(center)* pouring resin over preform *(right)* removing molding from hydraulic press

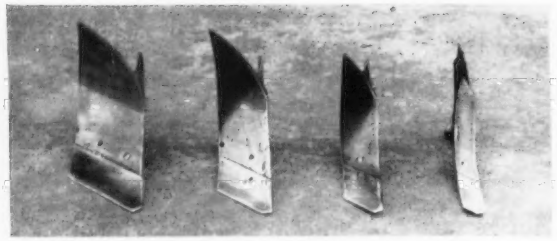

Fig. 1 Moldboard plow shapes: 8, 6, 4, and 2-in. widths

Relation of Size of Cut To Tillage Tool Efficiency

W. R. Gill and W. F. McCreery
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Research results point to smaller cuts as answer to improving field performance

THE tillage of a consolidated cohesive soil, by means of a wedge-shaped tool such as a plow, results in both bending and shearing or tearing the soil into smaller blocks(5)*. The distance between the cleavage surfaces may therefore be an index of the effectiveness of a tool. The size of these blocks becomes very large when a hard dry soil is deeply subsoiled or plowed, and it is frequently not practicable to break up these lumps unless they are softened by water.

Research by Payne (6) and Soehne (7) has indicated that the distance between cleavage surfaces increases with increases in the operating depth of tillage tools. Woodruff and Chepil (9) have reported increases of clods greater than 0.03 in. and 0.76 in. with deeper tillage in certain soils. A review of the literature indicates that the influence of the distance between cleavage surfaces on the breakup of the soil mass has not been studied. It was believed that, if the tillage forces were applied to a consolidated cohesive soil so that the cleavage surfaces were closer together, the resultant size of the soil clods would also be smaller. It was envisioned that the distance between cleavage surfaces could be varied by a change in the size of cut of a tool and that the effect of the distance could be measured by a clod size analysis.

Two important aspects of this hypothesis were: first, what would be the effect of the size of cut of a tool on the resultant clod size and, second, what would be the relative efficiency of the various sizes of cuts?

Methods

Two different basic shapes of tillage tools were used for this study. One was a standard 26-in. disk having a concavity of 4⅜ in. and an outside beveled edge. The disk was operated at an angle of 37 deg with no angle of inclination. The second shape was basically a moldboard plow; however, standard plows were cut so that different widths were available (Fig. 1). These implements were operated at 3 mph at a depth of 6¾ in. and at widths of 1 in., 2 in., 4 in., 6 in., and 8 in. The 1-in. and 2-in. cuts in the case of the moldboard-plow shape were both cut with the 2-in. shape, while all widths were cut with the same disk plow. A disk coulter was set to cut to the depth of the furrow and the combined forces of the coulter and the plow shape were measured.

A Decatur silty clay loam soil was tilled with a rotary tiller to a depth of about 15 in., wetted, and packed into a dense condition with a smooth rubber tire and flat metal rollers. Bulk density and moisture samples were secured at the time of plowing.

Prior to plowing each test furrow, plastic sheets were placed at each of two sampling sites in the bottom of the open furrow so that each new slice of soil could be held separately from the previously plowed furrows. The sections of the furrow which fell on the sheets were carefully transferred into buckets and taken into the laboratory for clod-size determination.

Clod sizes were separated by means of a rotary sieve similar to that described by Chepil (2). In cases where clods were too large to sieve, they were measured and weighed individually. The mean-weight diameter of each sample was determined by the method reported by van Bavel (8) in which the diameter at which the mean-weight of the sample occurs is used to represent the size of clods in the sample.

Plowing was done with the plow test unit of the Laboratory. The forces on the tools were measured by a recording dynamometer unit

The efficiency of the tool action was based on an amount of equivalent energy which was required to produce a given clod size. This equivalent energy was determined by a drop-

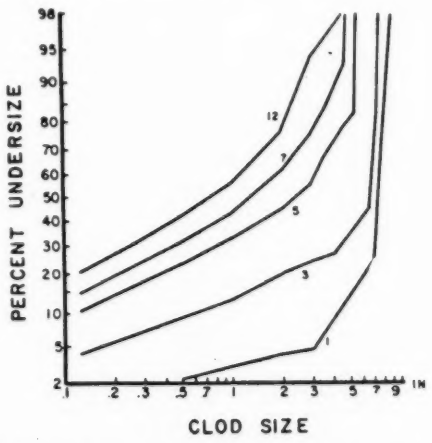

Fig. 2 Relation between the number of times clods are dropped and the clod-size distribution

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*Numbers in parentheses refer to the appended references.

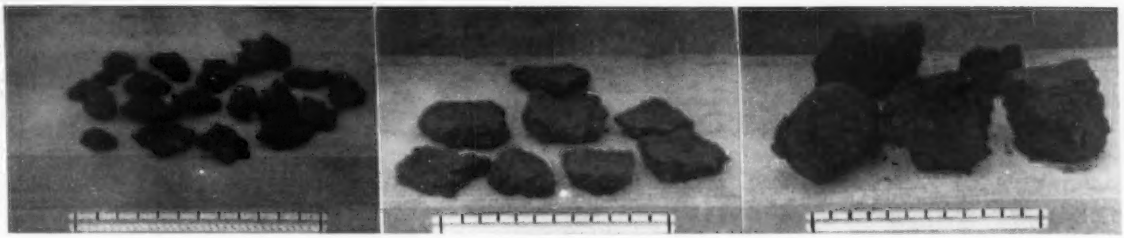

Fig. 3 Maximum clod sizes obtained by using different sizes of cuts: *(Left)* 1-in. cut; *(Center)* 2-in. cut; *(Right)* 4-in. cut

shatter method which has been utilized to determine the strength of coal and soil (1, 4). Large blocks of undisturbed soil, roughly 1 cu ft, were taken from the test plot and dropped from a height of 2.5 ft into a large flat pan on a concrete floor so that they would be shattered by the fall. The fragments were carefully recovered and the mean-weight diameter determined. In practice the use of two large pans eliminated the need to handle the soil in cases where more than one drop was desired. The equivalent energy applied to the soil to break the sample down to each size was calculated from the mass of the sample, the acceleration of gravity and the distance of the fall, and was expressed in foot-pounds. Unfortunately there was not a normal distribution of the clod sizes so that an easy technique of determining the mean-weight diameter from a log probability plot of the data was not possible. It was noted, however, that with repeated droppings of a single sample, the distribution did become more nearly normal. The data in Fig. 2 indicate that the plotted data tend toward a straight line as the number of drops increases.

An energy or work curve was prepared from the data secured in the drop shatter tests. The distance of the fall was great enough to cause shatter of the soil and the accumulated input energy from a given number of drops was plotted against the resultant clod size. The curve was taken as a characteristic of soil strength, since the nature of this curve was determined by the factors which determine the mechanical strength of the soil. The curve would be expected to change from day to day, but it would reflect the physical strength of the soil at any given time.

Results

1 *The effect of size of cut on the size of soil clods*

The Decatur soil was in a firm moist condition at the time of the experiments (Table 1). Due to difficulties in properly securing uniform soil conditions at all depths, it was not possible to conduct the experiments with different depths of cuts. A more satisfactory method resulted in varying the width of the cut so that the soil was moved laterally in all cases instead of vertically. This resulted in comparable samples in all furrow slices regardless of the thickness of the cut and the same principle was involved as it would have been with the use of depth.

TABLE 1. PHYSICAL CONDITION OF DECATUR SILTY CLAY LOAM AT TIME OF TILLAGE

Depth, in.	Percent moisture*	Wet density, lb per cu ft	Dry density, lb per cu ft
0-2.5	12.0	119	106
2-4.5	14.5	125	108
4-6.5	16.1	123	106

*Lower plastic limit 17.7 percent.
⅓ atm pct 22 percent.
15 atm pct 10 percent.

The draft measurements and mean-weight diameters which were secured for each of the treatments are shown in Table 2. It can be seen that the size of the clod decreases with decreasing size of cut. It is also seen that the draft per unit of furrow slice is generally larger at the smaller sizes of cuts. Fig. 3 indicates the nature of the largest clods which resulted from several of the moldboard-shape treatments. The presence of small clods indicates that more work has been done on the soil. The presence of a considerable number of the larger clods, such as those in Fig. 3 (right), would produce an undesirable condition of tilth since the mechanical strength of soils may increase very rapidly with drying (3).

TABLE 2. MEASURED DRAFT AND CLOD SIZES FOR DIFFERENT SIZE CUTS FOR EACH OF THE IMPLEMENTS

	Size cut, in.	Clod mean-weight diameter, in.	Implement draft, lb	Draft per unit area furrow slice, lb per sq in.
Plow and coulter	1.0	1.47	188	27.7
	2.0	3.55	217	16.0
	4.0	6.46	292	10.8
	6.0	7.07	473	11.7
	8.0	8.61	653	12.1
Disk	1.0	1.76	350	51.9
	2.0	3.66	533	39.6
	4.0	4.49	750	27.8
	6.0	4.19	1080	26.7
	8.0	5.13	1180	21.8
Rotary tiller	—	0.55	—	—

2 *The efficiency of different sizes of cuts*

An important consideration in the action of a tillage tool is that energy losses, such as friction and some forms of movement which do not affect the clod size, should not be counted. Work on the soil is then only considered when

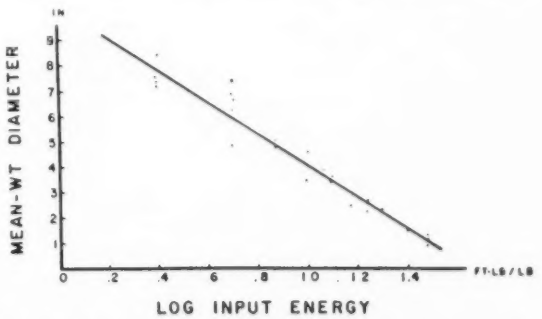

Fig. 4 Relationship between the input energy by dropping and the resultant shattered clod size

it results in the reduction of the size of the soil clods. As an example, if the aim is to reduce clod size, a harrow which merely stirs hard lumps without reducing their size would not be considered as doing work even though energy in the form of tractor fuel is consumed in the process. For this reason the energy input as measured by the drop-shatter procedure is taken as a base for efficiency calculations. Utilizing the number of drops and the distance which was 2.5 ft each, the equivalent energy for 1 lb of soil was calculated and the results are shown in Fig. 4. The graphical representation utilizes a semilog plot to facilitate the calculation of the regression line but the shape of the curve is not always of this form. The goodness of fit is seen by the plot and the regression equation expressing the curve was found to be $Y = 10.49 - 6.30X$, where X is the common logarithm of the equivalent input energy in foot-pounds and Y is the mean-weight diameter in inches. The standard deviation from regression Sy.x was 0.6 in.

With the data in Fig. 4, it is then possible to determine an equivalent amount of energy required to reduce the mean-weight diameter of the soil to a given point, had this energy been applied directly to the soil as in the dropping procedure. In order to accomplish this evaluation, it is necessary to express the data on a definite mass or volume of soil. An arbitrary volume of soil was chosen as a furrow slice 12 in. wide, 12 in. long, and 6¾ in. deep (0.56 cu ft). Work performed by the plow was expressed in terms of the product of force and distance utilizing the draft data from Table 2. As an example, it would take twelve 1-in. furrows of the disk plow to cut an equivalent furrow 12 in. wide, and the work to cut the furrow would be 12 furrows times 350 lb per furrow times 1 ft distance which would be equal to 4200 ft-lb. The values of the work done by the tools are shown in Table 3. The equivalent work done on the soil

TABLE 3. COMPUTED ENERGY VALUES FOR WORK DONE ON 0.56 CU. FT. OF SOIL

	Size cut, in.	Work to cut 1-ft furrow, ft-lb	Equivalent input energy by dropping, ft-lb	W_s/W_T
Plow and coulter	1	2256	1790	0.79
	2	1302	855	.65
	4	876	290	.33
	6	946	239	.31
	8	979	137	.14
Disk	1	4200	1639	.39
	2	3198	800	.25
	4	2250	602	.27
	6	2160	628	.29
	8	1770	498	.28

was secured by entering the mean-weight diameter resulting from each size of cut (Table 2) into the curve of Fig. 3 so as to be able to secure an equivalent energy input per unit weight of soil. Calculation of the total equivalent energy value was again based on 0.56 cu ft of soil. With an average wet density of 122 lb per cubic foot, the weight of this volume of soil was found to be 68.4 lb. Total computed equivalent energy values are shown in Table 3.

Based on the relationship between the energy from dropping and the soil breakup, it was possible to determine the efficiency of the various treatments in the following manner: The efficiency of each treatment was expressed in terms of

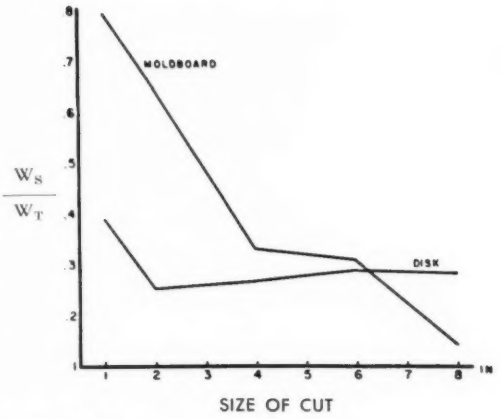

Fig. 5 Efficiency of tillage tools based on the equivalent input energy

the ratio between the work done on the soil W_s and the work done on the tool W_T. The ratios (W_s/W_T) which are shown in Fig. 5 indicate that small cuts are considerably more efficient than large cuts for the moldboard-plow shape. It is also apparent that the efficiency would continue to increase with smaller cuts. It can be seen that the disk plow is also more efficient at the 1-in. cut but that its efficiency is generally lower than the moldboard-plow shape.

Discussion

The principle of using small cuts has resulted in a reduction of the mean-weight diameter of the clod size of a consolidated cohesive soil. There is little reason to believe that this principle would have much effect on the size of clods in a non-cohesive soil, since the mechanical strength within the sheared blocks would be low.

If the principle is of benefit in those cases where the soil is hard at the time of tillage, another important consideration immediately arises. This is how should a mass of hard soil be reduced to a specific clod size in the most efficient manner. Intuitively it would seem that forces should be applied to a fixed mass in such a manner that the soil broken loose reaches the desired size in one step. This is the opposite approach from present practice, which is to progressively break a mass of soil down into smaller sizes by a series of different implements and operations. These operations can become quite inefficient since loose clods are free to move away from the tool which is to affect them.

It is possible that the equivalent energy as determined by the drop-shatter method can be used to determine the most effective manner by which to reduce the clod size of a hard soil. If this manner can be determined, a sounder basis will exist upon which to design tillage implements.

The rotary tiller utilizes the principle of small cuts but information is lacking on its efficiency of operation. While it has been reported that it requires three to four times more power per unit volume of soil than a moldboard plow, the effectiveness in terms of work done upon the soil is unknown. Certainly, since other tillage operations must follow the plow, the energy requirements of a rotary tiller may be considerably less than they first appear.

(Continued on page 381)

Hydraulics of Pipe Outlets for Tile Drains

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Basis for selection of correct size of outlet pipe for a tile drainage system

A COMMON problem in the design of a tile drainage system is the selection of the size for the outlet pipe. Corrugated metal pipe, often used for such outlets, has a high resistance to flow of water. The correct size of such pipe is that which does not restrict the flow in the tile main.

Literature on this subject is limited to friction studies of pipes. The Manning's n of corrugated pipes has been found to be near 0.025 (3)*, while the n for draintile has been accepted to be near 0.011. A common procedure is to use pipe one size larger or to increase the slope of the outlet pipe to help make up for the difference in capacity. Although this procedure is satisfactory in many cases, it does not represent an exact solution. The primary purpose of this paper is to present a theoretical solution to this problem.

An examination of three types of flow near a tile outlet is useful in approaching the problem of outlet-pipe size. All three types of flow are peculiar to a mild slope or a slope where the maximum gravity flow occurs at a depth greater than critical. In the first type, the tile flows uniformly at a depth near $0.94D$, where D is the tile diameter. Varied flow, the second type, develops near the outlet where the water surface drops to critical depth at the overfall. The surface profile of such flow is commonly referred to as an M_2 curve. The third type of flow occurs if the tile is flowing under pressure.

If pressure flow was common in a tile main near the outlet, a very large outlet pipe size would be required to prevent restriction of flow. Since Q, the quantity of flow, is inversely related to the roughness, n, the area of the pipe required would be greater than the tile area by a factor of 0.025/0.011, or 2.3. Fortunately, however, pressure flow is the exception rather than the rule at a tile outlet. This can be proven by considering the transition between maximum gravity flow and flow under pressure in a circular conduit. The conveyance, k, in a tile main is shown as a function of depth in Fig. 1. The relation between conveyance, slope and quantity of flow is given in equation [1].

$$Q = k\,S^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

in which Q = quantity of flow
k = conveyance
S = slope

Above $y = 0.94D$, an increase in depth results in a decrease in conveyance. This is an unusual circumstance in open channels. When the conduit flows full, the conveyance k_f ceases to change. An increase in flow can be obtained by applying a pressure difference along the length of the pipe. This line of pressure as measured in head of water from point to point in the pipe is referred to as the hydraulic-grade line. As the pressure gradient is increased, a point is reached where the flow in the pipe under pressure is equal to the maximum uniform gravity flow (2).

$$k_f S_h^{\frac{1}{2}} = k_g S^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

in which k_f = conveyance of the full pipe
S_h = slope of the hydraulic grade line
k_g = conveyance at maximum uniform gravity flow
S = slope of the pipe

or $$S_h/S = (k_g/k_f)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2a]$$

Since the ratio of conveyance at maximum gravity flow to the conveyance at full pipe flow is the same for all circular conduits, a minimum S_h/S may be established for steady pressure flow in circular conduits. From Fig. 1 this is $(1.07)^2$ or 1.15. Because of this limiting condition, fully developed pressure flow is not common in tile outlets. Exceptional cases may occur, if a surface inlet is near the outlet or if the outlet is submerged.

Since gravity flow is the most common outlet condition for a tile system, the profile of such flow may be solved using the varied flow equation. The general differential equation of gradually varied flow is

$$\frac{dy}{dx} = \frac{S - S_h}{1 + d/dx\ (V^2/2g)} \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

$\frac{dy}{dx}$ = slope of the water surface

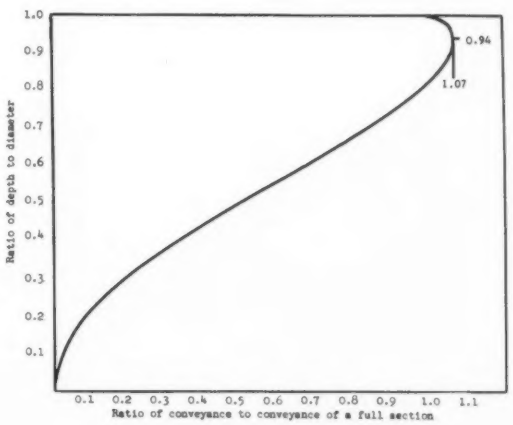

Fig. 1 Conveyance in a circular conduit

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*Numbers in parentheses refer to the appended references.

S=slope of the channel
S_h=slope of the hydraulic-grade line
V=flow velocity
g=acceleration due to gravity

This equation has been a difficult one to solve for circular conduits. Recently, however, Keifer and Chu (1) proposed a simplified method for exact integration of the varied-flow equation. This exact method is used for all solutions presented in this paper. The essential quantities necessary to solve the varied flow in a tile outlet are the quantity of flow, Q, the ratio of normal flow in the outlet pipe to normal flow in the tile, a, the slope of the tile outlet, S, the critical depth at the outlet, y_c, and the point where flow reaches the depth of maximum gravity flow. The length of the resulting curve may be set to represent a length of a corrugated outlet pipe. This is a maximum length, under which an increase in size is not necessary for unrestricted gravity flow from the tile.

Experimental Procedure

Since the varied-flow equation is not commonly used in small circular conduits, a model study was conducted to compare computed varied-flow curves with experimental data. A 4-in. (I.D.) lucite pipe, 60 ft in length, was used as the model conduit. This pipe was attached to the top of an I beam with a variable slope. The pipe has a free overfall and is connected to a regulated water supply. Regulation of the model slope is accomplished by a differential chain hoist arrangement similar to that used by Laursen (2). To reduce the effect of surface tension on the depth of flow in the model, the inside was coated with silicone grease. The roughness of the pipe was determined by measuring the friction loss under pressure flow. The Manning's n ranged from 0.0086 to 0.0095 for Reynold's numbers from 6×10^4 to 3×10^4, respectively. A value of 0.009 was used to solve the varied-flow equation for all model results presented here.

Since the flow in a tile outlet is primarily an open-surface phenomenon, the ratio of the Froude number (4) in the model to the Froude number in the prototype must be unity.

$$F=V/(gd)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [4]$$

in which V=flow velocity
g=acceleration due to gravity
d=a linear dimension
F=the Froude number

The Froude number is satisfied when the critical depth, y_c, in the model times a scale factor equals the critical depth in the prototype. The y_c values for various sizes and slopes of tile carrying maximum gravity flow are given in Table 1. To maintain these low values of y_c in the model, a smaller value of the normal flow ratio, a, in the model than that which would occur in a tile outlet was necessary.

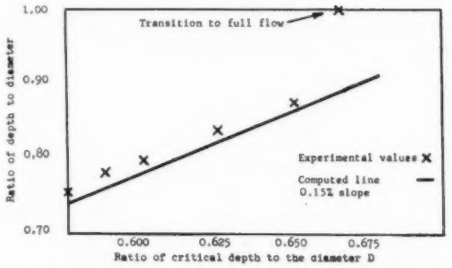

Fig. 2 Depth of flow of a constant distance from the outlet

TABLE 1. CRITICAL DEPTH FOR COMMON SIZES OF DRAIN TILE CARRYING MAXIMUM GRAVITY FLOW

Slope,	Tile size, inches									
per cent	6	8	10	12	14	16	18	20	22	24
0.1	.48*	.49	.50	.51	.52	.52	.53	.54	.54	.54
0.2	.58	.59	.60	.61	.62	.63	.63	.64	.64	.65
0.3	.64	.65	.67	.68	.69	.70	.70	.71	.72	.72

*Depth expressed as a ratio of critical depth to diameter of tile.

Results

Predicted values of the depth, y, using the varied-flow equation are compared to average observed values of y at a constant distance from the outlet in Fig. 2. As flow approached the outlet, a waviness was observed on the surface due to critical depth. This made depth measurements difficult. At the upper end of the M_2 curve, the water surface also became unstable. This unstable condition terminated in an abrupt rise to the crown of the pipe as shown in Fig. 3.

An example of a computed M_2 curve for the model is shown in Fig. 4. Two points on the lower region of the curve were determined experimentally. The point where the observed flow touched the top of the pipe was also determined. The varied-flow equation does not give a true picture of the water surface in the upper region of the pipe.

The locus of points which were determined from the varied-flow equation for the length of the M_2 curve as a function of y_c are plotted in Fig. 5 for two parameters, $y=0.90D$ and $y=0.85D$. The experimental distances to the point where the pipe flows full are also plotted against y_c. For a 0.15 percent slope and the given range of yc, most distances to the point where full flow occurs could have been predicted by computing the length of the M_2 curve to some point between $0.85D$ and $0.90D$. The experimental

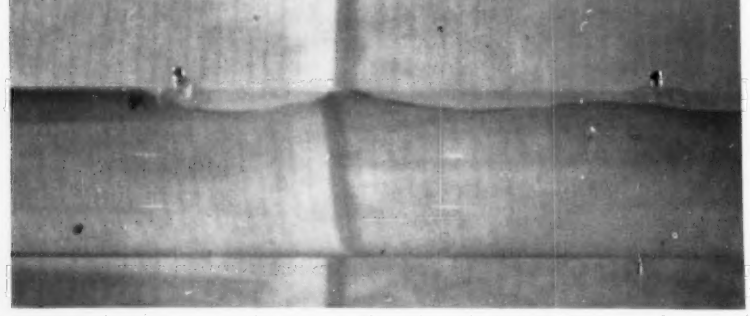

Fig. 3 Transition to full flow at a critical depth of 0.67 D

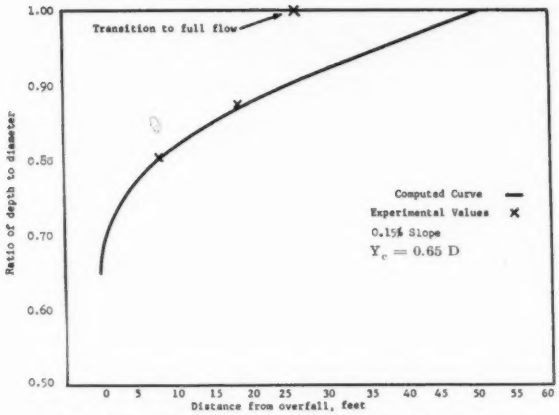

Fig. 4 Experimental points on a computed M_2 curve

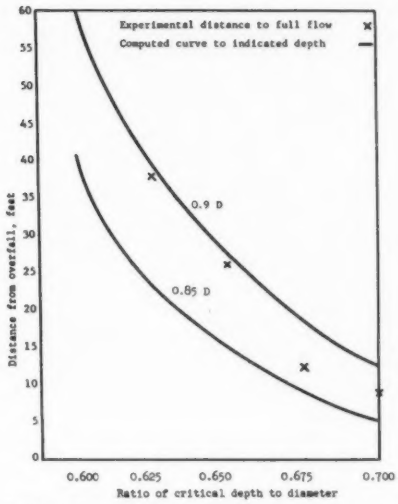
Experimental distance to full flow
Computed curve to indicated depth
0.9 D
0.85 D
Distance from overfall, feet
Ratio of critical depth to diameter

Fig. 5 Experimental distance of full flow and computed distance to parameters 0.85 *D* and 0.90 *D*

distances in Fig. 5 represent the average values from 3 tests. The range of distances which were observed varied from nearly 0 for a y_c of $0.625D$ to 3 ft for a y_c of $0.70D$. Apparently the point where the pipe flows full becomes less stable for large values of critical depth.

Similar observations were made with flow on a 0.1 percent slope. These also indicate that the full flow can be predicted by computing the M_2 curve to some point between $0.85D$ and $0.90D$.

Discussion

Experimental measurements verify computed values of depth on the lower part of the M_2 curve. There is, however, a departure from the predicted curve near the crown of the conduit. The conveyance curve suggests the reason for this phenomenon. At depths near $0.94D$ an increase in depth results in a decrease in conveyance. For a smooth water surface, as is assumed in the varied-flow equation, gravity forces steadily lower the water surface to critical depth at the outlet. Where the water surface is not smooth, waves increase in size near the region of decreasing conveyance. The fact that at deeper critical depths the instability of the surface increases supports this hypothesis.

Because of the unstable character of flow in the upper region of a circular pipe, the varied-flow equation should be integrated no farther than $y=0.85D$. This is a practical point where the pipe may flow full. Commercially available corrugated metal pipe was matched with draintile sizes from 8 to 24 in. to determine the critical pipe length in each case. These lengths are presented in Table 2. Beyond this length an increase in pipe size is necessary to prevent restriction of the tile flow by the pipe. No solutions of the varied-flow equation are presented for slopes greater than 0.2 percent. Such solutions could be made by the method of Keifer and Chu (1). For steeper slopes of the tile main the varied-flow curve is found to shorten rapidly.

TABLE 2. LIMITING LENGTHS OF CORRUGATED METAL PIPE FOR 0.1 AND 0.2 PERCENT SLOPE

Tile size, in.	Pipe size, in.	Length of pipe, ft	
		0.1 percent slope	0.2 percent slope
8	8	23	*
	10	120	53
10	10	28	—
	12	113	47
12	12	33	10
	15	95	76
14	15	66	24
15	15	40	12
16	18	62	43
18	18	47	14
20	21	72	23
21	21	53	15
22	24	104	37
24	24	59	16

*No values are given where the length is less than 10 ft.

Example: A 12-in. tile main is being installed on a grade of 0.1 percent. Gravity conditions will occur at the outlet during peak flow. According to Table 2 a 12-in. corrugated metal pipe may be used for outlet lengths up to 33 ft. A 15-in. pipe may be used up to 95 ft if a longer pipe is necessary. Diameters for longer lengths than this can be computed by solving the varied-flow equation for other commercially available sizes.

Summary

The varied-flow equation can be used to compute the size of corrugated-metal outlet pipes for gravity flow from tile mains.

A model study was made to determine the extent to which a computed M_2 curve follows the actual water surface in an outlet pipe. It was found that the water rises abruptly to the top of the pipe at the upper end of the observed curve. Such a rise is not predicted in the varied-flow equation.

The length of the surface curve to the point where common tile sizes flow full can be safely estimated by integrating the varied flow equation to a y of $0.85D$.

Limiting lengths of corrugated metal pipe can be found which will carry the maximum gravity flow from the tile main without any restriction. These pipe lengths are presented in tabular form for a 0.1 percent and a 0.2 percent slope of the tile main.

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Unloading Silos Mechanically

Martin Decker
Assoc. Member ASAE

DURING the past five to ten years many farmers have installed commercially produced silage-handling equipment in their search for a means of chore simplification. Mechanized methods of putting ensilage into storage have advanced much more rapidly than the mechanization of removing ensilage from storage and distributing it to livestock. This is due to the lack of uniformity of farmstead operations which makes it difficult to develop one unit which will fit the circumstances of every farm. This situation did not exist to such an extent in the case of field machinery. Because of this situation much of the farmstead equipment must be installed as part of an existing system.

Although the first silo unloader was manufactured shortly after the second world war, now over a dozen manufacturers produce them. Most operate satisfactorily; however, a few owners are dissatisfied. In general, mechanical difficulties or not understanding the limitations of the equipment cause dissatisfaction. Interest by farmers is high as they search for a way to increase efficiency and easing chores.

In the master of science thesis, J. T. Reid (8)* points to the importance of silo unloaders in today's agriculture. In 1950 about 38 percent of all farm labor went into livestock production (dairy and beef). Nineteen tons of material are handled per cow per year on dairy farms. This includes milk, feed, bedding, and manure. Silage constitutes about one-fifth of all material handled. Therefore, an efficient way to unload and feed silage mechanically would eliminate a large percentage of the labor involved in feed handling.

In 1958 an investigation was made of mechanical silo unloaders in operation on Kansas farms. Data were collected on five different makes by performance tests, with the regular farm help operating the unloaders. The machines tested were selected to represent manufacturer, farm size, livestock type, and geography of Kansas. Selection minimized as far as possible the effects of local conditions and standards of installation.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged jointly by the Farm Structures and the Electric Power and Processing Divisions, as contribution No. 91, department of agricultural engineering, Kansas Agricultural Experiment Station, Kansas State University.

The author — MARTIN DECKER — is research agricultural engineer, Kansas Agricultural Experiment Station, Kansas State University, Manhattan.

*Numbers in parentheses refer to the appended references.

Unloading Silage by Hand

As upright silos are unloaded either by hand or mechanical unloaders, it seemed appropriate to include some data on hand methods in this investigation. Hand unloading included the time necessary to climb the silo, dig the silage loose, and throw it down the chute. The study included only such operations and did not include removing doors or spoiled silage. The size of the silo may affect the rate of output. It was easier to throw silage across larger silos than to walk across. Silos of a diameter more than 16 ft required either walking or double handling. The physical stature of the man pitching has an effect on the rate of climbing the silo and handling the silage.

Rates of unloading corn and sorghum silage as observed on seven farms are shown in Table 1. All operators used a ten-tined silage fork. It is to be noted that the average rate of unloading for these farmers was 190.7 lb a minute or 5.7 tons per hour. The weight per forkful ranged from 10 to 22 lb, the average being 17.1 lb. The operator with the highest rate of unloading filled his fork to only 13 lb per forkful but established a fast rate of forking, 20.5 forkfuls per minute. The average rate of forking was measured to be 10.3 forkfuls per minute. The height or depth of silage in the silo affected output rate from the point of total time required for forking and climbing up and down the silo. The climbing time varied greatly with the physical stature and age of the farmer. One farmer climbed to a 25-ft silage level and down again in 1.2 min; another took 5 min to go up and down this same distance. It should be noted that a pitching rate of 177.6 lb per minute was reduced to only 98.2 lb per minute when a climing time of 5 min was included. Small operators, obviously, can save time by pitching down more than one feeding at a time.

Unloading Silage Mechanically

Two general types of unloaders are available for upright silos. One, known as the surface or top unloader, rides freely on top of the silage or is suspended by cables from the top of the silo. It is lowered gradually into the silage as unloading takes place. The other, a bottom unloader, is fixed in the bottom of the silo. As unloading progresses the entire mass of silage continually settles. This study was limited to surface unloaders since bottom unloaders were not marketed extensively in Kansas at the time.

TABLE 1. RATE OF UNLOADING CORN SILAGE FROM UPRIGHT SILO WITH HAND FORK

Farm	Forking time, min	Pounds silage	Pounds per minute	Tons per hour	Forkfuls	Pounds per forkful	Forkfuls per minute
1	16.25	1560	96.0	2.9	71	22.0	4.4
2	9.4	1320	139.8	4.2	88	15.0	9.4
	2.1	435	208.8	6.3	29	15.0	13.8
3	13.5	2574	190.8	5.7	117	22.0	8.7
4	19.1	3100	162.6	4.9	160	19.0	8.4
	6.2	1100	177.6	5.3	55	20.0	8.9
5	1.7	430	252.6	7.6	43	10.0	5.9
6	5.7	1320	231.6	6.9	76	17.0	13.3
	7.6	1320	174.6	5.2	73	18.0	9.6
7	8.3	2250	272.4	8.2	170	13.0	20.5
Average			190.7	5.7		17.1	10.3

Design and operational features of the unloaders are quite similar. They cut silage loose and carry it to a central point by augers or a gathering chain with spiked teeth mounted on a rotating arm. From the central point, the silage is picked up by a blower and blown through an open silo door.

The tests were run with the reg-

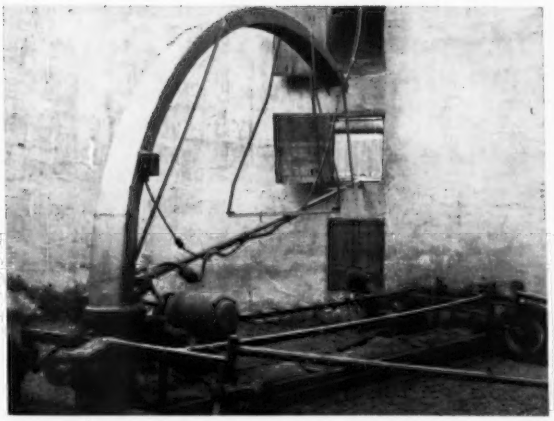

Fig. 1 A non-suspended type unloader, with enclosed auger, is shown riding on top of the silage in a 30-ft diameter silo. Two drive wheels are located at the outer end of the auger.

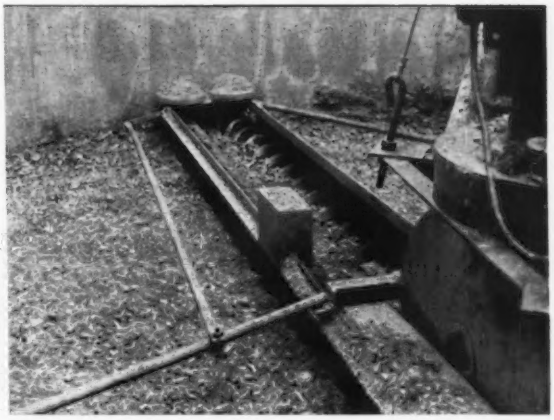

Fig. 2 Twin counter rotating gathering augers are used to cut loose hard-packed or frozen silage and convey it between them to the discharge unit

ular farm help operating the equipment, which yielded widely varied information. It was found that many machines were being operated without proper adjustment, and that by making a few changes in adjustments output could be increased. Current demand during a test was recorded to determine at what percent of rated load the motors were operating. The current fluctuated; however, large overloads were generally momentary. Table 2 is a summary of the unloader test data. In the column showing percentage of rated load it should be noted that most operators were loading their machines to full capacity. Some farmers operated their machines at 85 to 95 percent of rated load. These users were careful about loading motors on the machines to or above capacity because of previous experience with clogging. They felt they would lose less time this way than in climbing the silo to clean out a machine after it became clogged. The percentage of rated load at which machines were operated varied from a low of 77 percent to a high of 135 percent. The average for all tests was 107 percent of motor rating.

Table 3 lists the unloading rates and energy consumption averages. The averages do not take into consideration the individual makes of unloaders. In order to get a reasonable value for rate of unloading, the rates of corn and grass silage were averaged separately. Considering all unloaders tested, there was a range in capacity from 2.1 to 11.7 tons an hour with an average of 6.4 tons an hour for corn and sorghum silage. For grass silage the capacity varied from 3.7 to 4.03 tons an hour with an average of 3.9 tons an hour.

The average energy consumed was 0.88 kwh per ton for corn silage and 2.00 kwh per ton for grass silage. The energy consumption for grass silage was higher because of the lower unloading rate. Grass silage presents a different problem from corn silage. At a setting of the forage cutter all the grass is not cut the same length. Table 2 shows that the length of cut for grass silage ranged from ½ to 3 in. When the short and long silage is together, it is harder to tear it apart. This seems to be one explanation for the lower output with grass silage.

Motors

The unloaders tested were powered by 3, 5, and 7½-hp motors. The 3-hp motor is considered to have sufficient capacity for silos up to 14 ft in diameter; however, in three 14-ft installations the 3-hp motors were heavily overloaded. While some manufacturers use enclosed frame-type motors, most use an open-frame motor of drip or splashproof design. High capacity cooling fans on two motors sucked particles of silage into the motor and caused trouble in starting mechanisms.

Fusing and Wiring

As fusing and wiring to unloaders are generally left to those installing a machine, a wide variety of circuits were observed, from plain fuses to magnetic thermal overload motor starters. The motor-protection device on several was more than 125 percent of the rated full load current of the

TABLE 2. SUMMARY OF DATA ON SILO UNLOADERS TESTED IN KANSAS SHOWING UNLOADING RATES AND ELECTRICAL ENERGY CONSUMPTION

Test	Silo size, ft	Silage type*	Length of cut, in.	Percent moisture	Unloading rate		Motor size, hp	Percent of rated motor load	Energy input, kw	Kilowatts per ton
					lb/min	tons/hr				
1	20x60	S	½	67	334	10.02	7½+½	125	10.55	1.07
2	18x40	S	⅜	68	153	4.58	5+½	82	3.78	0.84
3	16x30	S	½	71	112	3.39	5+½	96	3.29	0.97
4	16x30	C	½	73	139	4.17	5+½	105	—	—
5	20x60	C	½	68	321	9.45	5+½	117	—	—
6	18x50	S	½	67	250	7.50	5	117	—	—
7	18x50	C	¾	67	107	5.03	5	108	3.30	0.66
8	18x35	S	⅝	67	135	4.04	5	107	3.68	0.91
9	14x30	C	¾	73	249	7.40	3+½	108	3.50	0.47
10	14x35	S & C	¾	63	74	2.21	3	114	3.32	1.51
11	14x30	S	½	71	154	4.61	3	108	3.38	0.73
12	18x45	B	½-3	71	126	3.79	7½+½	93	11.44	3.02
13	18x40	A & b	½-2	65	134	4.03	5	110	3.89	0.97

*S, sorghum; C, corn; B, barley; A, alfalfa; b, brome.

motor. One 7½-hp motor with a rated load of 35 amp was fused with 60-amp fuses. The original overload device was a 40-amp delay-action fuse. When the original fuse burned out, it was replaced with a one-time fuse, and a 60-amp fuse was the smallest that would not burn out under the starting current required by the motor. This was common on unloaders tested. Many unloaders with two motors had only a single thermal element through which both motors were fused. In effect, there was no motor-overload protection for the individual motors. Other unloaders with two motors had fuse boxes mounted on the unloader, with two delay-action fuses for each motor. Supplying 220 volts through slip rings and brushes to motors on the rotating portion of the machine has been generally satisfactory. However, contact in these devices is often poor causing a voltage drop across them. On one unloader powered by a 7½-hp motor, there was an 8-volt drop across the collector rings. This generated enough heat to melt the solder from a soldered terminal.

Many machines had only two slip rings, so positive grounding to the motor frame could not be assured. Many installations had a ground lead attached to the non-rotating portion of the machine. That provided a motor frame ground only part of the time through contact of the central support. Such contact may not provide sufficient current-carrying capacity to blow fuses in case of a line-to-ground fault.

Discharge Units

The most common method of discharge is through a curved or gooseneck discharge spout. There is generally one of two methods employed to move the silage from the gathering unit through the discharge spout. Some manufacturers use a paddle blower while others use a rotary impeller which has swinging hammers or paddles to throw the silage rather than blow it. One manufacturer uses a throwing device comprised of a rotary impeller with swinging hammers to lift the silage from the gathering augers to a discharge-auger conveyor. The discharge auger, powered separately by a ½-hp electric motor, provides positive delivery out the silo door. Another manufacturer adds a booster blower driven by a ½-hp motor in the gooseneck spout. Discharge blower or impeller capacities appeared to limit the unloading rates of machines. An investigation of the literature on the theory of impeller blowers shows little correlation between the blowers used and the theoretical.

TABLE 3. AVERAGE UNLOADING RATES AND ELECTRICAL ENERGY CONSUMPTION OF SILO UNLOADERS COMPARING 3, 5, AND 7½-HP MOTOR-DRIVEN UNITS

	CORN AND SORGHUM SILAGE				GRASS SILAGE			
Motor size, hp	Pounds per min	Tons per hr	Energy, kw	Kwh per ton	Pounds per min	Tons per hr	Energy, kw	Kwh per ton
3*	189	5.62	3.43	0.75	—	—	—	—
5	165	5.06	3.54	0.89	134	4.03	3.89	0.97
7½	334	10.02	10.55	1.07	126	3.79	11.44	3.02
All	213	6.40	5.18	0.88	130	3.91	7.66	2.00

*Most 3-hp machines were heavily overloaded.

Cost of Operation

Kilowatt-hour consumption was not a significant item to most users. With electricity at 2 cents per kilowatt-hour the machines tested averaged 1.8 cents per ton for corn silage and 4 cents per ton for grass. Total costs of operation, including electrical energy, labor, interest, taxes, depreciation, and repairs, varied from 39¢ to $2.39 per ton when annual tonnages of 1,000 tons to 100 tons, respectively, were handled. In establishing these costs, data in "Agricultural Engineers Yearbook" for a forage blower were assumed for silage unloaders. Depreciation was estimated on a straight-line basis for a 12-year life; 4½ percent of new cost was used as the total annual charge for interest, taxes, and insurance; 25 percent of new cost was assumed as total repairs for the life of the machine.

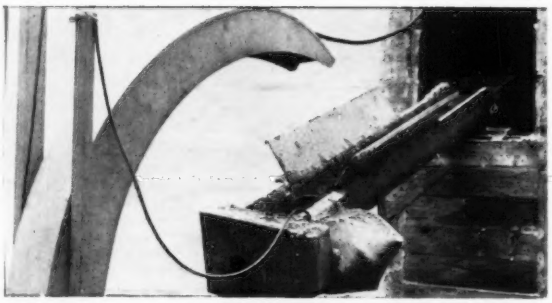

Fig. 3 Silage is raised by a rotating impeller with swinging hammers through the curved spout, dropped into a discharge auger and conveyed out the silo door

Conclusions

The investigation indicated much of the arduous and often dangerous portion of silage feeding is removed with the use of mechanical equipment. The results showed that there is a wide variation in operating performance and that a number of problems exist which need further study. These include improvement of the inadequate wiring practices and devices used, improved design for more efficient operation of machines, and difficulties with unloading grass and frozen and shredded silage.

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. . . Tillage Tool Efficiency

(Continued from page 374)

Summary

The size of cut of a tillage tool in a consolidated cohesive soil is an important factor in the resultant mean-weight diameter of the clods. The principle of utilization of small cuts might be profitably considered in the design and employment of tillage tools in hard soils.

A method to determine the efficiency of tillage tools and methods based upon an equivalent amount of work done to the soil has been developed which appears to offer a means by which to evaluate tools and their actions. It would appear that smaller size cuts are more efficient than larger cuts for a tool shaped like a plow moldboard, even though more fuel would be consumed in drawing the tool through the soil.

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. . . Molded Fiber Glass

(Continued from page 371)

pany now has in production a new dry fertilizer hopper which should run steady for a number of years.

There is much testing of prototype models now going on in the farm implement field. Some of these are liquid fertilizer, pesticide and insecticide tanks; grilles, hoods, engine covers, and full cabs for tractors and combines; safety shields and gear housings, a box for manure spreaders, and a number of applications on cotton pickers, combines, corn pickers, etc., which would involve making a one-piece molding out of what is now an assembly of many small metal parts.

Outlook for the Agricultural Equipment Field

The requirements for chemical-resistant agricultural tanks offer the best opportunity for applications of fiber-glass reinforced plastic. There are a number of different types of tanks being made by the hand-lay-up process at present, but they have not been widely accepted because of the high price per piece. Our company began investigating this field about a year ago and found so much interest that we decided to go ahead with our own dies. We are now in production on a 200-gal sprayer-storage tank which is 32 in. in diameter and 59 in. long. In the near future we expect to go into the production of dies for other sizes.

Agricultural experts familiar with the use of such equipment agree that very little care is given to anything of this nature. The equipment is seldom washed out after use, and it is likely to stand out in the open unprotected all winter.

The market for chemical-resistant tanks is great enough to warrant close investigation. Approximately 20,000 spray rigs were sold in Texas last year. In spite of the predominant use of 55-gal drums as tank replacements, 1,000 tanks were sold to replace equipment damaged by corrosion. While Texas figures are judged rather accurate, it is necessary to guess the sale in other areas. The best figures seem to be in the neighborhood of 60,000 sprayers sold per year and anywhere from 3,000 to 5,000 replacement tanks.

Liquid fertilizer tanks in the 200 to 500-gal sizes represent a rapidly growing market. It was impossible to get any estimate of the use of such tanks, but educated guesses range from 2,000 to 10,000 tanks per year.

Following are the results of tests on corrosion of structural materials by insecticides, herbicides, fungicides, and fertilizers made at the Texas Agricultural and Mechanical College: "Of structural materials tested, only two—Type 302 stainless steel and polyester plastic reinforced with fiberglass—showed complete resistance to all the solutions investigated. Either of these materials should be very satisfactory for tank or hopper construction if weight requirements can be met." These requirements can all be met in fiber-glass reinforced plastic tanks, if they are produced in matched metal dies so that the price per piece is competitive.

Another instance that merits close investigation is when design incorporating plastics may make possible the integration of structure or configuration which is not possible by conventional metal manufacturing methods. In this instance a still more favorable tooling outlook may be achieved, while elimination of subassembly operations required in metal may offset somewhat raw material cost differentials.

Where volume of components or equipment is relatively low by metal-manufacturing standards, but tooling prices are high, fiber-glass reinforced plastic may prove competitive due to lower unit cost for tool amortization. Normally, tooling for fiber glass can be produced for much less than the cost of tooling for sheet metal draw dies. For any application a break-even point can be determined by figuring the total part of production for which total costs including tooling are equal for metal and fiber glass. Below this figure, fiber-glass reinforced plastic would appear economically favorable.

The agricultural equipment industry offers many applications for employment of fiber-glass reinforced plastic. While function, performance, and cost are the prime criteria for success with agricultural equipment, the industry recognizes the sales value of improved styling. If sales appeal may be enhanced by color, pleasing configuration and an enduring appearance, fiber-glass reinforced plastic may well be considered.

Agricultural Engineering Phases of Teacher Education in Agriculture

Report III. Pre-Service and In-Service Education Programs*

THE purpose of this, the third report of the Committee, is to bring information up-to-date which was published in Reports I and II. This report is directed primarily to the attention of departments of agricultural engineering, but it should also be of interest to those in teacher education and supervisors of agricultural education.

Because of the rapid advance of farm mechanization and parallel developments in other fields, there is a growing need for better education of those entering agriculture. It is recognized that increased specialization and the ready availability of agricultural services have relieved farmers of many physical and mental duties that they formerly performed for themselves. For example, suppliers are available to mix and apply fertilizers and spray materials, and to compound feeds. Specialists will analyze soil and prescribe fertilizer treatments. Trained economists advise farmers on management problems. Veterinarians diagnose livestock ills and prescribe treatments.

The increase in "contract farming" (particularly among producers of canning and fruit crops, meat, and eggs) further relieves farmers of managerial risks, but requires them to be highly mechanized. To successfully use mechanical equipment, farmers need extensive training in its operation and service.

The proportion of graduates of colleges of agriculture who enter specialized fields related to farming is increasing. It is recognized that high school graduates who have studied vocational agriculture represent a major source for recruitment for agricultural college courses.

General Recommendations

Since many teachers of vocational agriculture presently devote 40 to 60 per cent of their high school teaching time to agricultural mechanics, as compared to 25 to 40 per cent commonly spent in the past, trainees need to have an increased amount of their undergraduate technical training in this field. More education in agricultural engineering technology† is also needed to adequately prepare teachers for their work with young farmers and adults.

The Committee recognizes the increasing importance of agricultural engineering in the future of farming. Agricultural engineering is considered to include two important areas:

1 Professional Agricultural Engineering—courses requiring a background of mathematics, physics, engineering fundamentals, and theory

2 Agricultural Engineering Technology — Service courses emphasizing simplified engineering principles usable in practical farm applications by other than professional engineers.

There have been marked improvements during the past few years in the course offerings in professional agricultural engineering curriculums. As a result, professional graduates are better trained and have earned a place of respect among other engineering groups. The Committee recommends that similar emphasis be given to improving courses in agricultural engineering technology, with the following points in mind:

1 That the course offerings be examined to make certain they are up-to-date and effectively meet the most pressing problems confronted by farmers — not simplified professional engineering courses.

2 That pre-service, graduate, and non-credit in-service courses be considered parts of a total program and be planned to supplement each other.

3 That staff members for teaching these courses be selected on the basis of their special abilities and field experience as well as on academic attainments in order to maintain a proper balance between applied and theoretical understandings.

4 That staff members who teach these courses be given status and opportunities for promotion equal to those who teach professional engineering courses. Effective teaching of agricultural engineering technology courses requires not only a thorough understanding of engineering principles but also special experience and ability in the application of these principles to the solution of farm problems.

5 That agricultural engineering technology courses provide fundamental training in basic principles so that teachers can keep up-to-date and adopt new techniques as they are developed. Additional courses emphasizing the application of principles, methods of teaching, and development of confidence should be provided to aid the trainee directly in his teaching.

6 That course work in agricultural engineering technology for teachers of agriculture should be related closely to the various enterprises in agricultural production. The ultimate goal of technical education is the production and processing of high quality agricultural products at low cost with minimum physical effort and make possible a high standard of living on the farm.

7 That departments of agricultural engineering and agricultural education be encouraged to conduct research studies, either jointly or individually, in an effort to develop improved programs of teacher education in agricultural engineering technology.

The five areas of training outlined under "Pre-Service Education" are those commonly recognized in agricultural engineering departments. Some overlapping may be noted in the objectives and activities suggested for these five areas. It is recognized that institutions vary in their organization. Some of the items listed may be included in courses offered by other departments, such as agricultural economics, agronomy, etc. This points up the need for close coordination between departments.

Although the listing of objectives is intended to be rather complete, not all are of equal importance in all geographic areas. *The objectives have been listed as general guides — not as rigid outlines.* Some attempt was made to list the more important objectives first, but the numbering should not be interpreted as a definite priority ranking.

The Committee recognizes that students as undergraduates cannot receive adequate instruction in all areas. Furthermore, this would not be desirable even if possible since the education needs

*This is a report of the Committee on Agricultural Teacher Training, Education and Research Division, American Society of Agricultural Engineers, prepared in collaboration with an advisory group of agricultural education specialists.

NOTE: The first report of this committee was published by the Society June 22, 1944. This was revised during the period 1949 to 1952, and the revision was published as Report No. II in August 1953.

†The term "agricultural engineering technology" has been selected by the Committee to identify college-level education in agricultural engineering below the professional level. Earlier terms, such as "farm mechanics," "farm shop" or "agricultural mechanics," are not descriptive of the intensity, breadth or type of education this Committee has in mind for teachers of vocational agriculture who must meet present-day farming needs.

of teachers are constantly changing. These facts accent the need for adequate in-service education. Consequently this outline is intended to serve as a guide for both pre-service and in-service education.

In-service education in these areas should include short intensive workshops, courses for non-graduate credit, and graduate courses as part of an advanced degree program. In addition to receiving education as undergraduates and as participants in in-service education programs, teachers will need to improve their skills, techniques, and abilities "on their own."

To obtain a proper fundamental background, it is suggested that college courses in mathematics and physics be included in the curriculums for those preparing to be teachers of vocational agriculture.

All five instructional areas in agricultural engineering discussed involve the use of physics and mathematics. It is, therefore, recommended that students be well grounded in these subjects at the high school level and that they take college courses in these subjects before taking courses in agricultural engineering technology. This will result in a saving of time and a better comprehension of subject matter on the part of the student.

PRE-SERVICE EDUCATION

Farm Power and Machinery

A — Objectives

Develop understanding of basic principles involved, judgment, and ability to:

1 Recognize and identify the fundamental principles involved in machines and the relationship of mechanisms and systems to processes and functions; and recognize that basic principles and processes are unchanging but that mechanisms vary with systems employed in machine design.

2 Select power units and machines with regard to adapting systems of machines to types of farming, considering the compatability of individual machines with other components of the machinery system; size and number of power units, hours of utilization, annual cost, and availability of custom rental and dealer service.

3 Operate, adjust, service and maintain farm tractors, including spark-ignition and diesel types, and small internal-combustion engines.

4 Operate, adjust and service field machines including lubrication, recognition of malfunction such as sources of harvest losses; make the operating adjustments and properly hitch implements; calibrate planting, fertilizing and spraying equipment.

5 Locate and remedy common operating troubles due to wear of parts, breakage, misalignment, and other improper functioning.

6 Plan and execute a program of preventive maintenance including protection-shelter, rust prevention, periodic inspection and adjustment to compensate for wear, and repair in anticipation of breakage and improper function.

7 Make repairs and replace parts.

8 Recognize the need for major repairs involving the use of specialized tools and equipment and determine appropriate methods of getting such work done by a well-qualified service agency.

9 Adjust, adapt and modify machinery to satisfy local conditions such as trash-cover control, hillside operation, specialized crop use and multiple hitching.

10 Determine and use safe operating practices with special emphasis on proper speed, protection from moving parts and stopping the machine to adjust and remove obstructions, and for refueling.

B — Suggested Procedures

1 Make a systematic analysis of the farm machinery and power needs on a particular farm and calculate the estimated machine power and labor costs of performing certain operations or producing certain crops. Consider the size and type of farm, crop rotation, acres and quantities of various crops grown annually, use of crops, time available for harvesting, storage, possibilities for custom work and for joint ownership of machines.

2 Systematically perform the various tractor maintenance and service jobs, including lubrication, carburetion, ignition, engine tune-up, trouble shooting and adjustments. Use of dynamometer suggested.

3 Study the major functions, adjustments, and safe operation of farm machines such as the disk or moldboard plow, mower, combine harvester, baler, forage harvester, or corn picker. Study fundamental principles that are related to care, maintenance, and safe operation to provide an understanding of the reasons for such practices. Perform maintenance and repair operations.

4 Plan the repairing and overhauling of one or more machines. Actually perform as much of this work as time and facilities permit. Make a preliminary examination to determine the repair work needed, and make a list of all worn or damaged parts that need replacement. Obtain and install repair parts, emphasizing careful and proper assembly and adjustment. Place special emphasis on efficient methods of acquiring these parts from suppliers, identifying parts by makes, models, and numbers.

5 Hitch a moldboard plow or other machine to a tractor and analyze and discuss the effect of different hitch adjustments. Field demonstrations and student participation are essential to understanding.

6 Make generous use of operator's instruction manuals, servicemen's repair manuals, appropriate slide films and motion pictures available from manufacturers and other agencies. Use these as aids to assist and as supplements to laboratory experience, not as substitutes for thorough, systematic instruction.

7 Have students perform actual repair and overhaul of small internal-combustion engines to acquaint them with operating principles, repair, overhaul procedures and need for care and cleanliness in quality workmanship.

8 Visit local farm equipment dealers. Become acquainted with all the dealers of your locality, know the types of machines they supply, and the facilities and methods in their service shop. Encourage and enlist their cooperation in your program and arrange for your students to visit their facilities.

Farm Buildings and Conveniences

A — Objectives

Develop understanding of basic principles, judgment and ability to:

1 Lay out a farmstead and plan an integrated farm improvement program, evaluate existing buildings, analyze the needs for new or remodeled construction, plan new buildings, develop a maintenance and improvement program recognizing basic requirements for farm dwellings.

2 Plan buildings for utilities and production equipment to meet the operating needs of the farmer: elevators, conveyors, water distribution and disposal systems, light and power, feed-storage, handling, and processing devices.

3 Recognize and meet requirements of farm animals and poultry for environmental and sanitation control, such as temperature, ventilation, light and moisture.

4 Select suitable building materials for specific uses, including durability, functional performance, strength, ease of application, availability, economy and appearance. Recognize standard commercial units, grade, estimate quantities and determine construction costs.

5 Recognize good construction methods and standard building materials.

6 Recognize and be prepared to correct common occupational hazards to life and property: fire, accident, wind, lightning.

. . . Teacher Education

B — Suggested Procedures

1 The farm structures and equipment area may be taught by survey and analysis of adjacent college or commercial farms. The survey should include type of farming, existing buildings, equipment, field layout, roads, fences, extent of soil and water conservation.

2 On a selected farm, replan a balanced building program for livestock, crops, and proper soils and water conservation.

3 In planning for new construction, review functional design for building plans; select barns, poultry houses, hog houses, machine storage structures, farm service centers, dwellings, etc., required for the particular farm operations. Make sketches to indicate changes made on selected plans.

4 Take field trips to inspect well-constructed and well-planned farm buildings and assist students in evaluating good construction practices. Point out good features and defects in arrangement, use of materials, or construction of buildings inspected.

5 Select standard building materials and demonstrate accepted methods of application for economy.

6 Determine water requirements of a farm and select a water supply and disposal system to meet its needs.

7 Select or prepare a plan for one or more building units; make a complete bill of material and estimate construction costs.

Soil and Water Management

A — Objectives

Develop understanding of basic principles involved, judgment, and ability to:

1 Make land surveys, read soil survey and aerial maps, and run levels and contours by using the farm level. Locate and place grade stakes, and make contour maps.

2 Plan terracing and simple farm drainage systems. Estimate costs of construction and maintenance.

3 Plan and lay out typical irrigation systems, considering the advantages and limitations of the various types and systems.

4 Maintain irrigation and drainage systems including the upkeep of terraces, spillways and ditches; service overhead irrigation layouts and correct defects in both drainage and irrigation systems; apply fertilizers in irrigation water.

5 Plan and lay out farm reservoirs including the choosing of the appropriate site; calculate the expected flow and capacity, determine the procedure in constructing the reservoir, construct adequate spillways, provide outlets and use practices that preserve earthen reservoirs and embankments.

6 Relate equipment and tillage practices to soil erosion control.

B — Suggested Procedures

1 Determine area, establish stations, record data, make rough sketches, and locate and place grade stakes.

2 Relate soil type, rainfall characteristics, and the amount of run-off to the following: vertical and horizontal distances between terraces, slope and spacing of draintile, height and width of terrace, slope or fall of terrace, waterways and outlets.

3 Take field trips to observe recommended construction procedures as well as finished projects in ponds, irrigation, and drainage structures. Also observe tillage methods used to control wind and water erosion.

4 Plan an economical irrigation system for a given farm, considering the water supply available, type of soil, topography of the fields, seasonal rainfall and moisture needs of the crop. Make an estimate of costs and benefits of the system.

Rural Electrification and Processing

A — Objectives

Develop understandings of basic principles involved, judgment, and ability to:

1 Plan wiring systems and rewiring for adequacy, convenience, and safety, including determination of probable future electric loads.

2 Select lighting equipment and locate it in the yards, lots, buildings, and work areas to provide adequate illumination.

3 Select electrical home appliances and farm equipment, including motors and controls. Consider safety, quality, energy consumption, life and servicing.

4 Adapt electricity to the farm enterprises, coordinating the equipment with the size and arrangement of the farm buildings.

5 Repair, service, and maintain electrical equipment. Locate and correct troubles and hazards in connection with fuses, controls, switches, fixtures, cords and wiring, motors, heating appliances, and lamps.

6 Install electrical equipment considering power transmission, equipment ventilation, servicing, safety, etc.

B — Suggested Procedures

1 Make a sketch of the farmstead showing the location of the buildings and list the existing and proposed electrical equipment to be used in each. Mark the location of switches, lighting fixtures, and appliance outlets. Visit electrical suppliers or equipment dealers and prepare a list of needed fixtures and equipment with approximate costs.

2 Check with a local power-supplier representative and electrical inspectors for recommendations for wiring new buildings and rewiring old buildings.

3 Plan wiring or rewiring layouts and lighting in buildings for adequacy, convenience, and safety.

4 Compare two or more pieces of equipment, such as gutter cleaners or water pumps, and judge them on safety, quality, durability, provisions for adjusting, cleaning, and lubricating.

5 Compute probable energy consumption of different appliances from name plate data or from tests. Figure sizes of wires for one or more motors on specified jobs using name plate data.

6 Make cost estimates of doing such jobs as brooding chicks, elevating feed, grinding feed and the like, using electricity as a source of heat or power compared to other common methods.

7 Apply knowledge of circuit and motor protection by proper selection of fuses, circuit breakers or controls, and by selecting wire sizes, grounding, polarization, and grounding of cords.

8 List electrically driven equipment involved for various farm enterprises such as egg production, broiler or fryer production, swine and dairy production. Develop a coordinated layout for a given wiring system to fit sizes of enterprise.

9 Perform maintenance jobs and simple wiring installations which can be done safely.

10 Recognize difficulties which require the attention of trained personnel.

Agricultural Construction and Maintenance
(Farm shop work)

A — Objectives

Develop understandings of basic principles involved, judgment, and ability to:

1 Promote the establishment of a home farm shop or farm service center.

2 Supervise and assist in planning, equipping, arranging, and managing a school agricultural mechanics shop.

3 Select hand and power tools and shop equipment for the school agricultural mechanics shop and home farm shop, including makes, models, sizes, quantities, and grades.

4 Sharpen, repair, maintain and safely use the common shop tools and equipment.

5 Install, safely use, service, and maintain power tools found in the agricultural mechanics shop.

6 Do electric arc and oxy-acetylene welding, including cutting, bronze welding and hard surfacing.

7 Do hot metal work, including bending, shaping, and heat treating.

8 Do cold metal work, including cutting, drilling, filing, tapping, threading, riveting, and bending.

9 Do sheet metal work, including cutting, bending, and fastening.

10 Do pipe and tubing work and make simple plumbing repairs.

11 Select lumber, hardware and other building materials and calculate bills of material.

12 Supervise and assist with construction and maintenance of smaller farm buildings and equipment.

13 Do painting and glazing. Apply wood preservatives.

14 Construct and maintain adequate farm fences.

15 Do concrete work including building forms, testing materials, preparing mixes, placing, finishing and curing; and laying concrete and masonry building units.

16 Make the more important rope knots, hitches, splices, and halters.

17 Recognize dangers and hazards connected with the use of tools and equipment and guard against them.

B — Recommendations

1 The agricultural construction and maintenance skills, abilities, and judgments should be taught wherever possible by providing practical experiences and relating these to actual farming situations.

2 Emphasis should be placed on good work habits and learning rather than on volume of projects completed. Specifically, quality and standards of workmanship should be consistent with the particular project involved.

3 The projects selected for construction, repair, and maintenance by students should be of practical value, and typical of the projects emphasized in agricultural mechanics courses for high school students, young farmers, and adult farmers.

4 The equipment and facilities in the teacher training laboratories and in high school teacher training centers should be similar or superior to the better equipped and organized high school agricultural mechanics shops found in the state. Maintenance and adjustment of this equipment should be especially emphasized in the teacher education program.

5 The students should become safety conscious as a result of employing standard safety practices throughout the agricultural mechanics courses, including use of safety colors, ventilating systems, proper guarding and use of shields, and safe work habits.

In-Service Education

The Committee recognizes that:

1 In-service education of teachers of vocational agriculture is becoming increasingly important because:

(a) There is an increased complexity in engineering applications to agriculture in modern farming

(b) More teachers are making a career of teaching vocational agriculture.

(c) The pre-service education period does not allow sufficient time to give the prospective teachers all of the needed preparation at the undergraduate level. Consequently teachers in the field need a strong in-service education program.

(d) Teachers must be kept up-to-date on new developments in agricultural engineering technology.

(e) There is a growing interest at the local community level to provide more adequate school agricultural mechanics facilities. These facilities must be manned by well-trained teachers in order that they may be of greatest service to their communities.

2 In-service education of vocational agriculture teachers is a responsibility of institutions preparing teachers in this field as a part of their continuing education program. This requires that the various institutions recognize the need for providing an adequate staff and sufficient funds to enable them to fulfill these in-service responsibilities.

RECOMMENDATIONS

1 In-service education should be offered both on and off campus, but greater emphasis should be placed on such training offered off campus. The courses should make use of such mediums as "doing activities," demonstrations, and group discussions.

2 The size of class sections should be limited to a maximum of about fifteen.

3 For best educational results, the courses should be sufficiently long to provide time to accomplish the desired objectives. It will be necessary to offer these courses both during the school term and the summer months.

4 Members of the agricultural engineering staff who teach courses for teachers of vocational agriculture should visit vocational agriculture departments in their states in order to get a better understanding of the needs of vocational agriculture teachers.

5 Agricultural engineering departments should work in close cooperation with agricultural education and state supervisory staffs in the preparation of subject matter material and teaching aids to implement the effectiveness of the in-service education program.

6 Graduate courses both on and off campus should be provided for teachers of vocational agriculture. These courses should be designed to meet the needs of both the candidates for advanced degrees and those teachers interested only in professional improvement. They should include education in all of the recognized areas in agricultural engineering and the organization and methods of teaching agricultural mechanics.

7 The possibility of utilizing the services of educational departments in industry should be investigated.

Respectfully submitted,

COMMITTEE ON VOCATIONAL AGRICULTURE TEACHER TRAINING

V. J. Morford, chairman, Agricultural Engineering Department, Iowa State University

J. W. Matthews, vice-chairman, Agricultural Engineering Department, University of Illinois

M. M. Jones, Agricultural Engineering Department, University of Missouri

A. A. Stone, special representative, International Harvester Co.

A. H. Hollenberg, specialist in agricultural education, U.S. Office of Education

J. P. Schaenzer, agricultural engineer, Rural Electrification Administration, U. S. Department of Agriculture

C. H. Jefferson, director, Reynolds Farm Institute, Reynolds Metals Co.

R. P. Marvin, Department of Agricultural Engineering, University of Minnesota

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H. W. Kitts, Department of Agricultural Education, University of Minnesota

David Hartzog, Department of Agricultural Education, State College of Washington

PM Technical Committee Holds Workshop Meeting

The Technical Committee of the Power and Machinery Division of ASAE and four of its subcommittees held a two-day workshop meeting at the Whitcomb Hotel in St. Joseph, Mich., May 3 and 4. L. H. Hodges, chairman of the committee, called the meeting in lieu of the regular summer meeting, which is usually held in conjunction with the Annual Meeting of ASAE, in order that additional time could be devoted to a large number of items placed on the agenda. Another factor which influenced the committee in its decision to hold a workshop meeting was the convenience of follow-up action by the committee of any action taken by the subcommittees. The first day was devoted to subcommittee meetings following a tour of ASAE headquarters. In the afternoon tours of local industries included Research and Development Center of Whirlpool Corp., automated foundry and brake plant of Auto Specialties Mfg. Co., and Lakeshore Division of Bendix Corp. Following a social hour through the courtesy of Auto Specialties Mfg. Co. and dinner, subcommittees reconvened for evening meetings. The following subcommittees met: V-Belt Standardization Subcommittee, John H. Zich, chairman; Tractor and Field Machinery Service Data Subcommittee, John M. Cole, chairman; Manure Spreader and Wagon Box Capacity Subcommittee, M. J. Happe, chairman; Wagon Running Gear Rating Subcommittee, D. F. Nelson, chairman.

During the day-long session on the second day the Technical Committee received several subcommittee reports and considered a host of important matters dealing with the standardization of farm equipment. The agenda included items concerning tire selection tables, upper link for 3-point hitches, auxiliary PTO drives, PTO standards, farm safety, farm tractor controls, V-belt standards, tractor and field machinery service data, manure spreader and wagon box capacities, wagon running gear ratings, review procedure for ASAE Standards, fertilizer hopper capacities, disc harrow widths, bolt torque, nomenclature of farm hydraulic loaders, hydraulic system capacities, and blower and elevator hopper standards.

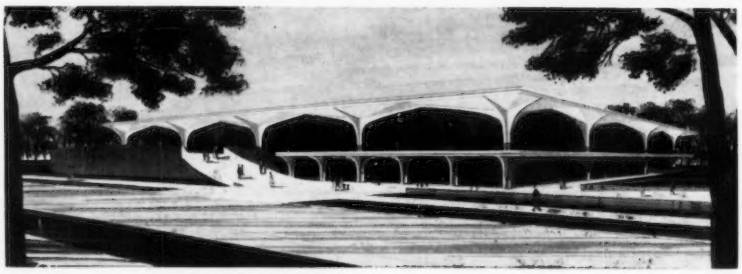
Recent air service into St. Joseph-Benton Harbor, the nearness to ASAE headquarters, and excellent hotel facilities make St. Joseph worth consideration for future meetings by other ASAE committees.

Tractor Power and Safety Day

The University of Nebraska Tractor Power and Safety Day is scheduled for Thursday, July 21, at Lincoln. This full day of demonstrations and discussions will be focused on new developments in farm tractors, featuring the new tractor models that have been tested since last July; experimental tractors such as the Allis-Chalmers fuel-cell tractor and the new John Deere 8010 tractor; new developments in materials handling equipment; a radio-controlled tractor; and other such outstanding events. The day has become known as one of the outstanding field days in the midwest, and a registration of more than 4,000 is expected.

(Continued on page 392)

TECHNORAMA — Exhibit Hall for Farm and Home Equipment



Plans for a modernistic concrete and glass building to house exhibits of the latest in farm equipment techniques and food processing methods to be built on the campus of Michigan State University, East Lansing, were revealed April 27, at the Detroit Press Club, Detroit-Leland Hotel. The new educational facility is to be constructed from fees to be paid by exhibitors and cooperators from industry, and will bring the story of new developments in agriculture to the public by exhibits, conferences and meetings, guided tours and through the mass communications channels of press, radio, television and film. Without charge, the public will be able to see the latest types of processes, buildings, equipment, materials and machines for agricultural production, processing, transportation and family living. A. W. Farrall, head of agricultural engineering, MSU, expressed hope that ground would be broken before the end of the year.

Bulletin

As the Journal goes to press, word has been received that Charles A. Ocock, Charter-Life Fellow, of Racine, Wis., died recently. Further details will be carried in July issue.

Leaders of four subcommittees confer with chairman of Power and Machinery Division Technical Committee during Workshop Meeting held May 3 and 4 at Whitcomb Hotel, St. Joseph, Mich. *(Left to right)* D. F. Nelson, product design engineer, John Deere Industrial Equipment Works, and chairman of Wagon Running Gear Rating Subcommittee; John H. Zich, chief implement engineer, Tractor and Implement Div., Ford Motor Co., and chairman of V-Belt Standardization Subcommittee; John M. Cole, engineer, J. I. Case Co., and chairman of Tractor and Field Machinery Service Data Subcommittee; M. J. Happe, product test manager, New Holland Machine Div. of Sperry Rand Corp., and chairman of Manure Spreader and Wagon Box Capacity Subcommittee; and L. H. Hodges, director of engineering, J. I. Case Co., and chairman of the Technical Committee

EVENTS CALENDAR

June 20-24 — Annual meeting, *American Society for Engineering Education,* Purdue University, Lafayette, Ind. Contact W. Leighton Collins, College of Engineering, University of Illinois, Urbana, for information.

June 26-July 1—Annual Meeting, *American Society for Testing Materials,* Chalfonte-Haddon Hall, Atlantic City, N. J. Contact Society headquarters, 1916 Race St., Philadelphia 3, Pa.

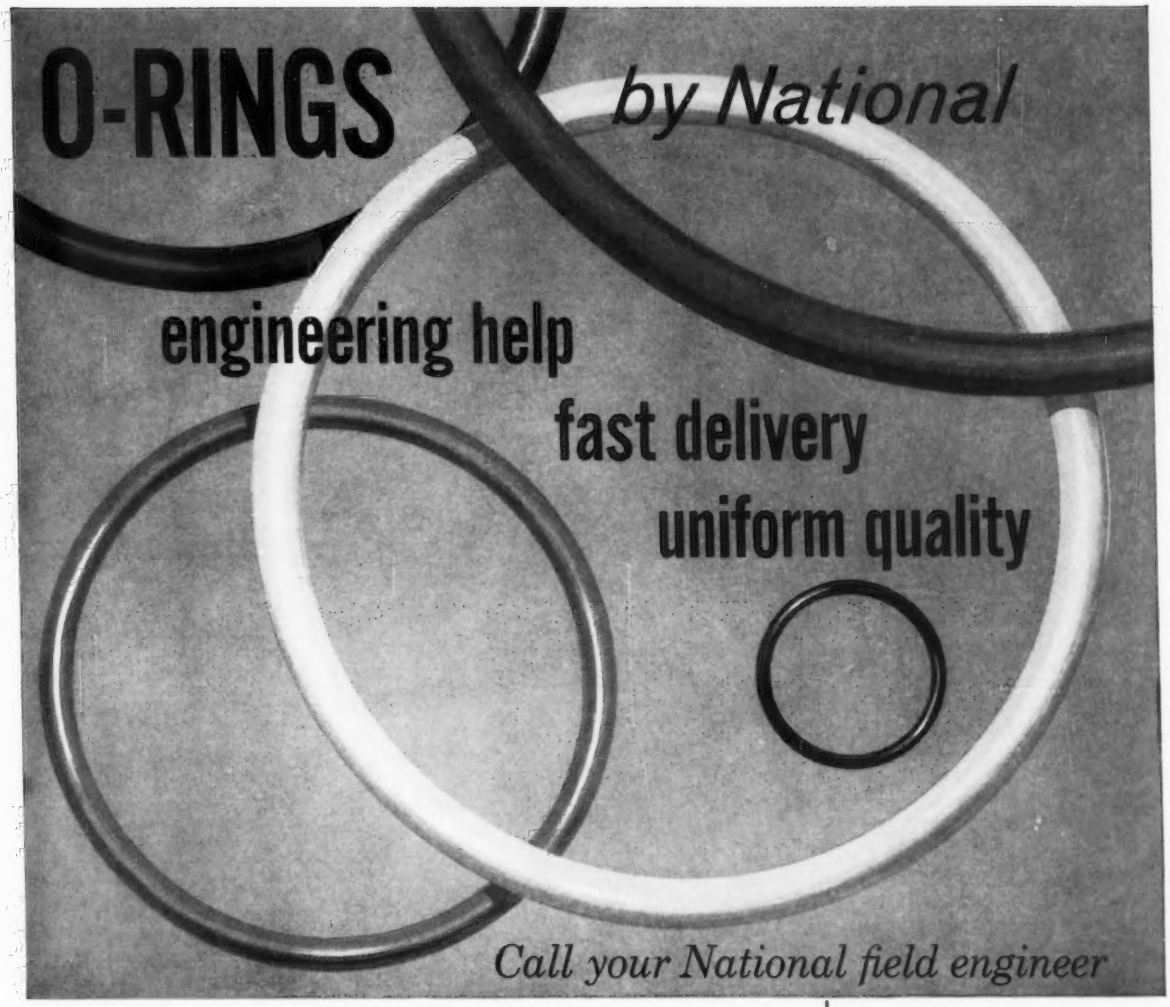
June 27-July 23 — *7th International Vacation Course,* Technische, Hochschule, Stuttgart, Germany. For further information contact Gunther Habich, executive chairman, Buro fur Internationale Ferienkurse, Stuttgart, Huberstr. 16, Germany.

July 11-15 — 3rd annual *Institute in Technical and Industrial Communications,* Colorado State University, Fort Collins. Write to Director, Institute of Technical and Industrial Communications, Colorado State University, Fort Collins, Colo., for further details.

July 24-30 — *National Farm Safety Week.*

August 7-10 — *Summer Conference, American Institute of Cooperation,* University of California, Berkeley. For additional information write AIC, 744 Jackson Place, N.W., Washington 6, D. C.

(Continued on page 399)



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5600

H. F. Miller

D. L. Van Orman

E. K. Bonner, Jr.

H. F. Miller, former chief, harvesting and farm processing research branch, AERD, ARS, USDA, Beltsville, Md., has joined the product research department of Deere & Co., Moline, Ill. Prior to 1952, he was research engineer with the Texas Agricultural Experiment Station, College Station, Texas, and is chairman of the Power and Machinery Division of ASAE for the 1959-1960 year.

D. L. Van Orman, formerly Minneapolis district manager, industrial division, Timken Roller Bearing Co., recently has been appointed Philadelphia district manager of the industrial division. He started with the company in 1935 as a clerk and has been successively an industrial division sales engineer at Milwaukee, Wis., and Minneapolis, Minn., prior to his appointment as Minneapolis district manager.

Edwin K. Bonner, Jr. has been made chief engineer of West Point Products Corp., West Point, Pa. He comes to the company from the S. L. Allen Co. of Philadelphia, where he was chief engineer.

J. W. Zahradnik, associate professor of agricultural engineering at the University of Massachusetts, has been awarded a fellowship by the Danforth Foundation, which will cover a 12-month period starting in September 1960. He has been granted leave from the University, where he has served since 1954, to do advanced study toward a doctorate. He plans to study at the Massachusetts Institute of Technology.

C. L. Day, associate professor of agricultural engineering at the University of Missouri, will attend a special institute on nuclear energy June 20 to August 12, at North Carolina State College, Raleigh, and at Oak Ridge National Laboratory, Oak Ridge, Tenn.

J. R. Lambert has received a National Science Foundation Fellowship, effective June 1, 1960. This will enable him to complete an M.S. degree at the University of Florida and also to do work toward a Ph.D. degree at another institution.

M. D. Hill, general manager, Tractor and Implement Div., Ford Motor Co., was one of two new members named to the National Committee on 4-H boys and girls club work. The election took place on May 3 at the annual meeting of the Committee's board of directors in Chicago.

J. W. Zahradnik

C. L. Day

H. O. Leslie has been transferred from Chain Belt Company's Moline, Ill., office to its Chicago sales office as a district sales engineer. He has been associated with the Moline office since 1956, as a district representative.

J. A. Jordan, formerly zone manager for International Harvester Co. in Maine, is now located in Huntington, N. Y., where he is associated with Edwin Ehrbar Inc. as a salesman of construction equipment.

H. R. Roberts, regional farm engineer, Portland Cement Assn., Atlanta, Ga., has been transferred to its Richmond, Va., office as district farm engineer.

J. C. Rigney, who formerly was an assistant engineer in the tractor engineering department of Allis-Chalmers Mfg. Co., Milwaukee, Wis., has accepted a position of design engineer with the Clausen Works of J. I. Case Co., Racine, Wis.

T. R. Shelley recently accepted the position of assistant chief, engineering division, of the Veterans Administration Hospital in Fort Bayard, N. M. Previously, he was with the Soil Conservation Service as an agricultural engineer.

W. M. McAdams, an ASAE member since 1938, has retired from Clemson College, after 19 years service, with the status of associate professor emeritus. He is at present doing a limited amount of professional work as agricultural research consultant, and is also engaged in some general farming. A native of Abbeville, S. C., he graduated from Clemson College in 1938 with a B.S. degree in agricultural engineering. He was awarded a county research and teaching fellowship at the University of Georgia where he received an M.S. degree in 1939. Since that time he has been connected with Clemson, teaching until 1953 when he was transferred to the Experiment Station and named associate agricultural engineer. He was acting department head for a period in 1955.

(Continued on page 394)

NECROLOGY

C. L. Oheim

J. W. Randolph

Curt L. Oheim, vice-president in charge of product planning, Deere & Co., Moline, Ill., died on May 29 in Moline Public Hospital, following a brief illness.

A native of Texas, he was born in Henrietta in 1894 and received a B.S. degree in electrical engineering from the University of Texas in 1918. During World War I, he served in the aviation section of the Army Signal Corps. He joined the John Deere organization in Dallas, Texas, in 1919, and was successively serviceman, assistant salesman, salesman, division sales manager, manager of the power machinery department, sales manager and general manager of the branch in that city. In 1943, he was transferred to Kansas City to become general manager of the branch there. He was elected a vice-president of Deere & Co. in 1951 and named head of product planning the following year. During the Korean War, he served in Washington as director of the agricultural machinery and implement division of the National Production Authority. In recent years he has been an adviser on farm equipment and machinery of the Business and Defense Service Administration of the U.S. Department of Commerce.

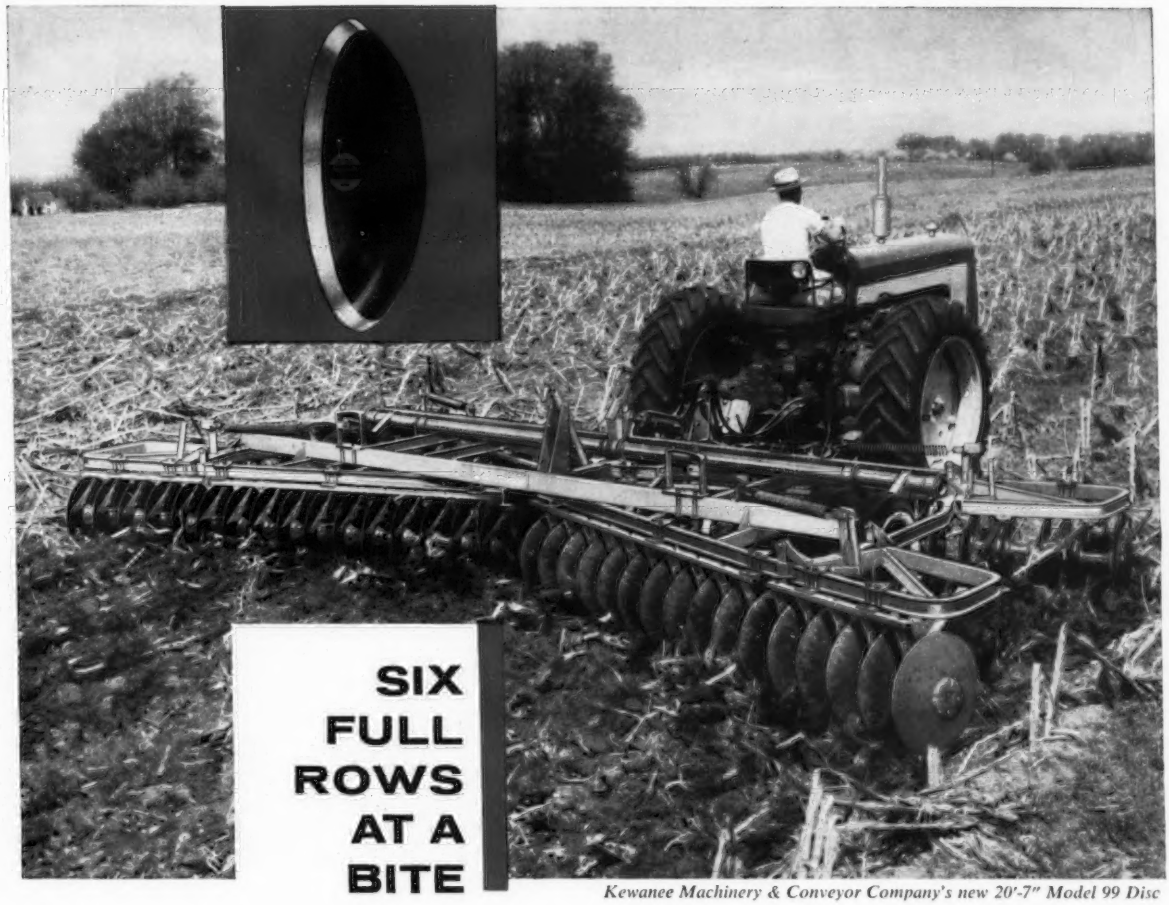
He had been an ASAE member since 1952, and also was a member of the Society of Automotive Engineers. In 1959, he was elected president of the Farm Equipment Institute after serving one year as chairman of the executive committee. He is survived by his wife, Cora.

John W. Randolph, Sr., agricultural engineer, Everglades Experiment Station, Belle Glade, Fla., died April 18, at Jackson Memorial Hospital, Miami, Fla., after a brief illness following an operation.

He was born in Iroquois County, Ill., in October 1896, and received a B.S. degree in agricultural engineering in 1920 from the University of Illinois. He served in the U.S. Navy during World War I and was an engineering instructor at Alabama Polytechnic Institute after being discharged from the service.

In 1931, he became agricultural engineer with the USDA and was placed in charge of the Tillage Laboratory at Auburn, Ala. After brief periods of service with the USDA in Washington, D.C., and Mississippi he left the Department in 1942 to take a position with the United States Sugar Corp., where he designed machinery for various research projects. He joined the staff of the Everglades Experiment Station, Belle Glade, Fla., as an agricultural engineer in 1947, and during the subsequent years made substantial contributions to crops production in the Everglades region. His research has included design of tillage, spray and harvesting equipment needed in

(Continued on page 394)



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Mid-Central Section

The Mid-Central Section recorded its largest attendance in the Section's history at the 13th annual meeting, held April 8 and 9 at the Hotel Robidoux, St. Joseph, Mo. The total attendance was 150, of which 93 were members, 49 students, and eight visitors and guests. "Out-of-Section" guests were E. A. Silver, New Holland Machine Co., and Claude L. Fly, Soil and Water Research Division, ARS, USDA, Fort Collins, Colo.

In the general interest program, topics covered included: Tractor performance studies; pellet handling systems; environmental control; flow problems of feed and grain; hydraulic characteristics of surface irrigation; minimum tillage research; lagoon waste disposal systems; vegetated waterway studies; grain aeration systems; and factors influencing agricultural engineering enrollment in the Mid-Central Section area.

On Friday evening, April 8, the after dinner speaker, Charles Clay, president of Farmecon, an equipment, engineering and construction company of Cedar Falls, Iowa, discussed a new approach to developing the building and equipment package on the farm. He used color slides to illustrate his address, which emphasized using concrete building walls, which are formed and placed in the shop, hauled to the site, erected with special equipment and then anchored to preplaced footings by welding together the footing and pre-cast wall reinforcing rods.

Of special interest to students was a "get acquainted" coffee hour on Friday morning with the coffee and doughnuts furnished by courtesy of Noel Tweet and The Iowa Engineering Society. Lee Lamar, P. E., St. Joseph, Mo., discussed "Engineering Registration and the Professional Engineer" with students from the four-state area. Paul Doll and the Missouri Society of Professional Engineers furnished the Saturday morning coffee for members and students.

At the business meeting on Saturday morning the following officers were elected for the 1960-61 term: C. W. Bockhop, chairman; T. O. Hodges, vice-chairman; D. B. Brooker, vice-chairman; P. E. Schleusener, vice-chairman; Verne Dvorak, secretary-treasurer; and R. E. Stewart, nominating committee chairman. The group voted to return to St. Joseph, Mo., for the 14th annual meeting on April 7-8, 1961.

Quad City Section

Approximately 200 members and guests of the Quad City Section met on April 22 at the John Deere Harvester Works, East Moline, Ill., for a tour of the plant, which placed particular emphasis on the forge shops and combine assembly line. Immediately after the tour there was a demonstration of the "Aeromobile" by its builder and inventor, William Bertelsen. Following this demonstration, the group convened at the American Legion Club, Moline, Ill., where Mr. Bertelsen described the "Aeromobile" and its possible application and use on the farm. After dinner, which was attended by 250, I. B. Jensen, sales manager, Riehle Testing Machines Div., American Machine and Metals Co., discussed fatigue testing equipment, using slides to illustrate practical examples of the use of this equipment. National ASAE President L. H. Skromme, chief engineer, New Holland Machine Co., also addressed the group, presenting a very interesting and informal talk in which he related many incidents that occurred during his travels throughout the country attending ASAE meetings. The election of the following new officers for the coming year was announced by Robert Skromme, chairman of the nominating committee: Robert G. Morgan, chairman; Martin A. Berk, vice-chairman; William M. Adams, vice-chairman; William B. Haley, secretary; Vernon W. Thede, treasurer; and Leroy T. Gordon, nominating committee chairman.

ASAE MEETINGS CALENDAR

August 21-24—North Atlantic Section, University of Massachusetts, Amherst,

September 9—Washington, D.C. Section.

September 13-15—Farmstead Engineering Conference on Confinement Housing of Livestock, Lincoln Hall Theatre, University of Ilinois, Urbana, Illinois.

October 19-22 — Pacific Northwest Section, Empress Hotel, Victoria, B.C., Canada.

April 7-8 — Mid-Central Section, St. Joseph, Mo.

April 14-15 — Southwest Section, Grim Hotel, Texarkana, Texas.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

West Virginia Section

The West Virginia Section held a dinner meeting at the West Virginia University Medical Center on April 22, with 22 in attendance. Dr. Homer Patrick, head, poultry science department, was the featured speaker and discussed the use of gamma rays in agriculture. He also included a description of the gamma irradiator, which he has located at the University poultry farm, and the possibilities of improving poultry strains with mutations. During the business meeting the following officers were elected: A. B. Holland, chairman; V. H. Flesher, vice-chairman; R. A. Phillips, secretary-treasurer; and A. W. McMillan and J. E. Wetsel, councilors.

Ohio Section

The Ohio Section held its Spring meeting on May 6 at Ohio State University, Columbus, in conjunction with the Annual Conference for Engineers. The business meeting was held in Ives Hall and consisted of a brief session to announce the election of the following officers for the coming

(Continued on page 392)

(Left) **New officers for the Mid-Central Section were elected at the Section's annual meeting, held April 8 and 9 at the Hotel Robidoux, St. Joseph, Mo. *(Left to right)* Leon Charity (Iowa), member of nominating committee; T. O. Hodges (Kansas), vice-chairman; D. B. Brooker (Missouri), vice-chairman; C. W. Bockhop (Iowa), chairman; R. E. Stewart (Missouri) nominating committee chairman; and P. E. Schleusener (Nebraska) vice-chairman. Verne Dvorak (Nebraska), secretary-treasurer, was not present at the time the picture was taken.**

***(Below)* Retiring chairman of the Quad City Section, John Ackley, greets the new chairman, Robert Morgan, and other new officers for the coming year: *(left to right)* Ackley; Morgan; Martin Berk, vice-chairman; William Adams, vice-chairman; William Haley, secretary; Vernon Thede, treasurer; and Leroy Gordon, nominating committee chairman.**

***(Above)* Student Branch officers elected at the Mid-Central Section annual meeting on April 8 and 9 at the Hotel Robidoux, St. Joseph, Mo., are: *(left to right)* Charles Farnham, Kansas, state vice-president; Dave Currence, Missouri, secretary-treasurer; John Miller, Iowa, state vice-president; Keith Saxton, Nebraska, section vice-president; Hal Judy, Kansas, section president; Lee Ott, Nebraska, state vice-president; and Don Sayre, Missouri, state vice-president.**

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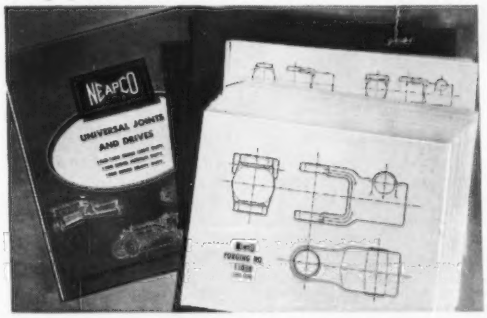

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. . . With ASAE Sections

(Continued from page 390)

year; H. J. Barre, chairman; R. V. Morr, vice-chairman; S. G Huber, secretary-treasurer; and E. S. Jue', W. R. Schnug, and M. L. Palmer, nom. ting committee. The top Ohio Section Student paper was presented by David L. Horn, who was presented with a $25.00 award.

Washington, D. C. Section

The Washington, D. C. Section held a luncheon meeting on May 13 in the South Building, USDA, Washington, D. C., at which Gladwin E. Young, deputy administrator, Soil Conservation Service, USDA, Washington, D. C., was the featured speaker. His topic was "Twenty-five Years of Progress in Soil and Water Conservation." During the business meeting the following officers were elected for the coming year: John G. Sutton, chairman; Robert L. Green, vice-chairman; and John W. Rockey, secretary-treasurer. The next meeting of the Section will be held on the second Friday in September.

Chicago Section

The Chicago Section, at the suggestion of its executive committee, held its April 27 meeting at the Embers Restaurant, Madison, Wis. The change in meeting location was decided upon so that the many ASAE members living in Wisconsin could attend a Section meeting without a trip to Chicago. A total of 67 (with only a few from Chicago) attended the meeting, indicating high interest. The meeting theme was "The Contribution of Specialized Farm Machinery Manufacturers to American Agriculture" and the program featured a panel discussion. Don Huhn, chief engineer, Gehl Brothers, West Bend, Wis., and Phil Zink, senior project engineer for hay equipment, Farmhand Materials Handling Implements, Hopkins, Minn., participated in the discussion.

North Atlantic Section

The North Atlantic Section will hold its annual meeting on August 21-24 at the University of Massachusetts, Amherst. According to R. W. Kleis, chairman, Local Arrangementes Committee, the program chairmen have formulated excellent programs for the members' professional benefit. The ladies' program will provide for their enjoyment, while the comfort, entertainment, and safety of the children will also be provided. Further details will be carried in the July issue.

The Michigan Section elected new officers for the coming year at its May 6 meeting, held at the American Legion Club in Battle Creek, Mich. They are: *(left to right)* Edwin Miller, vice-chairman; William Wathen, vice-chairman; Cecil Wolsey, retiring chairman; Ralph Frevik, chairman; and Robert Aldrich, secretary-treasurer. Absent when the picture was taken was Robert White, also a new vice-chairman

Michigan Section

The Michigan Section held a Spring meeting on May 6 at the American Legion Club in Battle Creek, Mich., at which the following officers were elected for the coming year: Ralph C. Frevik, chairman; Edwin L. Miller, vice-chairman; William A. Wathen, vice-chairman; Robert G. White, vice-chairman; and Robert A. Aldrich, secretary-treasurer. Tours of the Oliver and Kellogg plants were highlights of the program. National President L. H. Skromme was the featured speaker at the evening banquet. An added feature of the evening was the announcement by President Skromme that unbeknown to Earl Anderson, past-president and ASAE Council member, the Council approved the election of Mr. Anderson to the grade of Fellow of ASAE.

President L. H. Skromme *(right)* reveals a well-kept secret when he presents letter to Past-President Earl Anderson, director, agricultural extension, Stran-Steel Corp., Detroit, Mich. announcing that he has been elected to the grade of Fellow of ASAE, during Michigan Section meeting May 6

. . . News

(Continued from page 386)

F. L. Rimbach Receives National 4-H Award

Francis L. Rimbach, member of ASAE, along with eight others, was presented a citation at the Friends of 4-H General Assembly, during the National 4-H Conference, held on April 29, in the Departmental Auditorium, Federal Extension Service, USDA, Washington, D.C. He earned the award for his interest and support of 4-H Club work over the years, through obtaining support from sources other than his field, helping to prepare materials for 4-H Club leaders and members in the 4-H electric program, and his leadership in agricultural engineering as it relates to youth programs.

Dayton Rubber Changes Name

Word has been received that the shareholders of The Dayton Rubber Co. granted permission to change the corporate name to the Dayco Corp. by an overwhelming margin at the company's recent annual meeting.

Seventh ISS Congress

Sponsored by the Soil Science Society of America, the 7th International Soil Science Congress will be held August 15-23 at the University of Wisconsin, Madison. Soil scientists from all countries having diplomatic relations with the United States are invited to attend the Congress. About 400 scientific papers will be presented by the world's leading soil scientists, representing the seven sections or commissions of the Society, namely: I Soil Physics; II Soil Chemistry; III Soil Microbiology; IV Soil Fertility; V Soil Genesis, Classification and Cartography; VI Soil Technology; and VII Soil Mineralogy.

Western Snow Conference

Ways by which men can control the growth of winter's snowpack in the high mountains of the west; make water yields from mountain snows greater, more uniform and more dependable; and to defend themselves against the avalanches which bring death and destruction each year were among the topics that occupied the 100 delegates to the 28th annual Western Snow Conference in Santa Fe, New Mexico, April 12 to 14.

Other topics include new push-button methods for keeping tab on snowpack, air temperature, snow quality and soil moisture at remote mountain stations; use of electronic computers for predicting runoff; means for lowering evaporation from reservoirs; trends in precipitation; use of planes and helicopters to gather snowpack information; and new instruments for measuring snow and water.

The Conference chose Spokane, Wash., for the 1961 session. Dates, regularly in April, will be announced.

IBAE Changes Name

The Institution of British Agricultural Engineers is now known as The Institution of Agricultural Engineers, which was changed to conform with the title originally desired by the founding members in 1938. At that time it was not possible for the Institution to be registered as the Institution of Agricultural Engineers due to a number of similar titles already registered with the Board of Trade. It was only recently that some of those registered in earlier years have been withdrawn and that the Institution has been granted permission to use the new title.

1960 Nuclear Congress Papers

The Nuclear Congress, held in New York City's Coliseum on April 4-7, produced new information in a variety of subject areas related to the application of nuclear energy for mankind's benefit. The papers presented at the Congress were selected and invited so as not to duplicate any presented during other atomic conferences, and to fill gaps in information currently available. For those who found it impossible to attend the 1960 Nuclear Congress and to obtain printed

(Continued on page 394)

2 low-cost ways to modernize!

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Available with ½" or ⅝" bore in 5¼" and 7¾" pulleys for B and C Section belts. 17MM bore in 4" pulley for A Section belts only.

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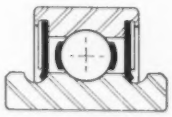
Where idler pulleys are used on belt drives, Fafnir's "economy packages" offer manufacturers low-cost ways to modernize design.

These sturdy pressed steel units feature Fafnir precision Plya-Seal ball bearings securely housed in the pulley stampings. They are permanently prelubricated and fully protected against contaminants.

The pulley halves are strongly riveted together, with spot-welding for track reinforcement in the flat-belt type. Rolled-over edges prevent belt chafing and insure utmost safety . . . weep holes allow water drainage in horizontal mountings.

Send for bulletin containing specifications and full information. Write The Fafnir Bearing, New Britain, Connecticut.



Fafnir Plya-Seal Ball Bearing with flexible, contact-type seals of Buna-N rubber-impregnated fabric offers "best protection yet" against contaminants, loss of lubricant. Extended inner ring precludes the need for spacers when mounting pulley.

FAFNIR
BALL BEARINGS

. . . ASAE Members in the News

(Continued from page 388)

His tenure here was broken only by three-years' duty with the U.S. Navy during World War II and a few months thereafter as engineering consultant at the Yuma Valley Experiment Station, Ariz. His Experiment Station work was mostly with tillage and planting methods of row crops, which included experiments in minimum tillage and wheel-track planting methods.

F. L. Rimbach, director of rural development of the New England Electric System, Clinton, Mass., recently has retired. He will, however, act in a consulting capacity to the system. He is a native of Massachusetts — his birthplace being Charlestown and spending his early years in Arlington. He attended Kansas State University and Harvard University. He served in World War I and organized, recruited and commanded a National Guard company in Worcester, Mass., during World War II. He was military and personal aide to Governors Saltonstall and Herter. During and immediately after attending college he was chatauqua director in 36 states. For two years he was executive secretary of the National Association of Mutual Savings Banks and in 1929 was called to organize the agricultural development department of the New England Electric System, which organization he has served for the past 31 years.

He has been an ASAE member since 1930, and has been active in the North Atlantic Section since joining the Society, serving the Section as chairman for the year 1958-1959. The New England Rural Electrification Committee was organized by him in 1929. He has also been active in civic and farm youth organizations, having attained the status of "honorary state farmer" of the Future Farmers of America and recently received a National 4-H award for outstanding 4-H work.

He and his wife, the former Pearl Darling of Bridgeport, Conn., have four children and reside on a 65-acre farm in Sterling, Mass.

H. S. Smith, president and co-founder of Smith-Gates Corp., Farmington, Conn., has retired from active management participation. He will continue to be a director and will serve as chairman of the board. A native of Gouverneur, N. Y., he attended Union College, the University of Illinois and was graduated from Case Institute of Technology in 1939, with a B.S. degree in mechanical engineering. After a short period with the New York Central and Santa Fe railroads, he joined Baker-Vawter Co., Benton Harbor, Mich., as a mechanical engineer, and three years later was made manufacturing superintendent.

In 1919, he came to Connecticut as an industrial engineer for Trumbull Electric Manufacturing Co. in Plainville, and in 1932 was named manager of a special products division to develop, manufacture and market products for use in the burgeoning rural electrification field. He resigned from this position in 1947 to co-found Smith-Gates. During World War II, he served on the Poultry Advisory Committee of the War Production Board.

He has been an ASAE member since 1938, a director of the Bristol, Conn., Savings Bank and is active in church and civic activities. He resides in Plainville with his wife, the former Margaret E. Campbell of St. Joseph, Mich. The Smiths have two children — a son and a daughter.

F. L. Rimbach

H. S. Smith

C. T. Sturdivant, an ASAE member since 1946, has retired recently from the International Cooperation Administration, Washington, D.C., and is now doing advisory work and ranching in Afton, Okla. A native of Oklahoma, he was born in Vinita and attended Oklahoma State University, Stillwater. His most recent assignment prior to his retirement was an overseas mission to El Salvador. He also has served as agricultural engineer at the Institute of Inter-American Affairs, Lima, Peru, and with the Servicio Agricola Inter-Americano at LaPaz, Bolivia.

C. R. Henry, manager of The Oliver Corporation's Washington, D.C., office recently has retired. He will enter into private business in the field of consulting, public relations, and government and export sales, representing the manufacturer. For 35 years, he has held numerous positions in the plant, branch offices, and the export division of The Oliver Corp., including the last 14 years as manager of the Washington, D.C., office.

. . . Necrology

(Continued from page 388)

vegetable, forage, and fiber crops production; work and machine efficiency studies; farm structures; fiber processing and handling; processing and preservation of foods and forages; drainage and irrigation. His latest field of intensive study has been the designing, development and testing of methods and equipment for reducing the moisture in livestock foods and forages. His ideas and basic research on the mechanical dewatering of forages are attracting wide attention and potentially may result in a real break-through in the more efficient utlization of these crops, especially in tropical and sub-tropical areas.

He has been an ASAE member since 1921 and was active in its Florida Section. He also had served on the following ASAE committees: Farm Work Efficiency; Soil Tillage; Tractor Tire; and Dehydration. He also held memberships in the Soil and Crop Science Society of Florida, and the Onarga, Ill., Masonic Lodge No. 305, A.F. and A.M., and had been a committee chairman for National Farm Equipment Manufacturers. His name had been listed in Who's Who of American Engineers. His wife, Orlean, and a son, John W., Jr., survive.

Paul Huey, vice-president and director of advertising for *Progressive Farmer* magazine, Birmingham, Ala., died February 5, the victim of a heart attack, while on a Caribbean cruise. He was a native of Texas, his birthplace being Cleburne, and he received a B.S. degree in 1925 from Texas A. and M. College. From 1925 to 1927 he served as agricultural agent in Hale County, Texas. Subsequently, he was associate editor of the Texas edition of the *Progressive Farmer* magazine in Dallas, and later its western advertising manager, with headquarters in Chicago, Ill.

Paul Huey

L. C. Wessinger

He served in the Air Force during World War II and held the Legion of Merit and four battle stars. At the time of his death he was a lieutenant colonel in the Air Force Reserves. He had been an ASAE member since 1940, and also held memberships in the Rotary Club, the Knights-Templar, the Birmingham Committee of 100, the Shriners, and the Birmingham Agriculture Club. He had been chairman of the agricultural committee of the Birmingham Chamber of Commerce, and last year was named a director of the Audit Bureau of Circulation. He is survived by his wife, Mary McCuen Huey, of Birmingham.

Lucius C. Wessinger, division rural engineer, Georgia Power Co., Rome, died on April 4 at the Floyd Hospital in Rome, Ga. A native of Georgia, he was born in Bowdon, graduated from the Bowdon High School, and from the University of Georgia, where he specialized in education, science, and agricultural engineering. He served as principal of schools in Clayton and Carroll counties, Ga., before joining the Georgia Power Co. in 1945. He was rural engineer at the Augusta Division before his transfer in September, 1959, to the Rome office. He is survived by his wife, a son, and a daughter.

. . . News

(Continued from page 392)

copies of papers, provision has been made for mail order distribution. This facility has been provided as a part of the first objective of the Congress, "to provide free exchange of knowledge in the subject area between engineers and scientists and the industry which is dependent upon such information." A list of 49 available papers will be furnished upon request from the American Society of Agricultural Engineers, 420 Main St., St. Joseph, Mich.

Two AE Students at CSU Receive Awards

The E. B. House award of $500 presented at Colorado State University for the 1960-61 school year has been given to Ted Zorich, a junior in agricultural engineering. The award, sponsored by the Abel-Hanger Foundation of Houston, Texas, is given to an outstanding junior engineer on the basis of need and interest in the teaching profession. E. B. House, for whom the award was named, was a professor of civil engineering at Colorado State University.

One of the two awards given annually by the mechanical engineering department to the two top students in design was awarded to Clayton Enix, a senior in agricultural engineering. It is quite unusual that such an award be given to a student outside the mechanical engineering department.

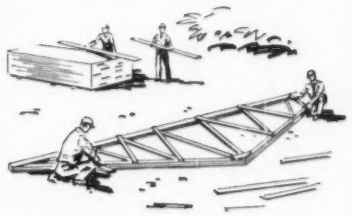
Now a single roof truss system you can recommend for all types of farm buildings

This new Weyerhaeuser System will handle *spans* of 40 through 80 ft. . . . *spacings* of 8 through 16 ft. . . . and *loadings* from 30 lbs. per sq. ft. through 45 lbs. per sq. ft. *Slope* is the same in all sizes: 4/12. Every engineering detail has already been worked out and blueprinted for 326 clear span situations. Just send your span, spacing, and loading requirements for 24-hour service on plans and material lists. Ask for Weyerhaeuser Roof Truss System No. 4064.

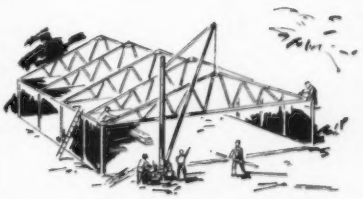
Buildings utilizing this truss system offer all the advantages of wood construction (durability, economical construction and maintenance, easy alteration or expansion) . . . and at the same time provide the desirable features of clear span construction.

In addition to post-free interiors, building with this truss system permits placing windows and doors wherever desired. Siding and roofing can be selected to complement existing farm buildings. The whole system—covering 326 different clear span situations—has been carefully engineered so that buildings will withstand heavy wind and snow loads. You can recommend it with confidence: both as an economical way to meet a farmer's existing building needs, and as a sound capital investment for his farm.

See your Weyerhaeuser 4-Square Lumber Dealer for information about other Weyerhaeuser Clear Span and Pole-Type Building Designs, other farm buildings and equipment, and farm homes. Or write: Weyerhaeuser Company, Dept. AE 26R, First National Bank Building, St. Paul 1, Minn.

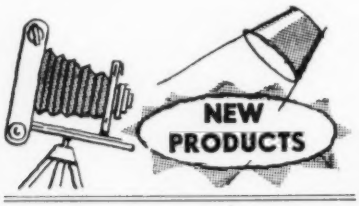


1 Detailed drawings and complete material lists speed assembly. It's safer, more economical because you work on the ground.



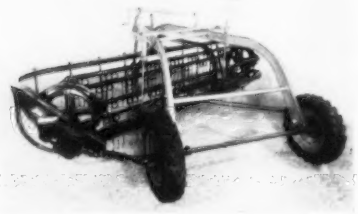
2 Crane is used just one day—when posts (or poles or tapered timbers) are in place and all trusses are ready for assembly.

Weyerhaeuser Company
Lumber and Plywood Division



Bean Rake

New Idea Farm Equipment Co., Coldwater, Ohio, has announced the new No. 401 bean rake. Designed primarily for

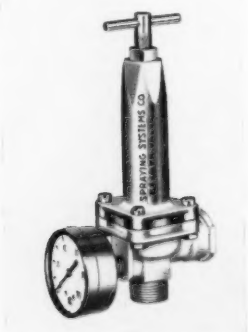


areas producing edible beans, the new rake will windrow four rows of beans planted in 30-in. rows with an 8-ft effective raking width. Each of five tooth bars has 27 teeth compared to 18 teeth per bar on the No. 400 parallel bar rake. The new rake serves double purpose being able to rake a full 7-ft swath onto clean stubble.

Optional equipment includes an adjustable bean hitch which offsets the rake to enable the tractor to straddle rows. Dual wheels, leveling crank and hydraulic lift for the basket are other extras.

New Pressure Relief Features

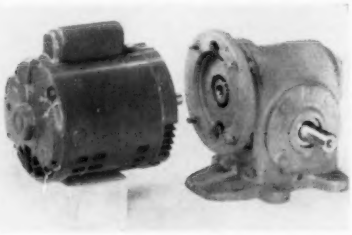
Spraying Systems Co., 3226 Randolph St., Bellwood, Ill., has developed a new pressure relief valve for use on farm



sprayers designed for improved performance and greater resistance to chemicals. The liquid-contact face of the valve is a special corrosion resistant diaphragm said to provide chatter-free pressure control. Supporting the setting of the diaphragm is a dual stainless steel spring assembly, consisting of a light spring for the lower pressure range and a heavy spring for the high pressure range up to 300 psi. For corrosion resistance all parts of the valve that come in contact with chemicals are made of nylon and stainless steel. For complete information write to the company for Bulletin 101.

C-Flange Gear Motor Announced

Morse Chain Co., Ithaca, N. Y., has announced that maximum versatility and adaptability have been built into its new Eberhardt-Denver "C-Flange" gear motor. A wide range of capacities and reductions are available. Motor and reducer are separate, flange-connected, therefore the unit is



furnished either as a complete assembly, or the reducer alone. Capacities range from 1/12 to 2 hp, reductions from 5:1 to 60:1. A free catalog is available from the company.

Boom Extension for Sprayers

Delavan Manufacturing Co., West Des Moines, Iowa, has announced a new BX spray nozzle available as both a single and

double nozzle and designed for coverage ranging from 68 to 104 in. for single nozzles and from 153 to 194 in. for double nozzles when both are placed at 30-in. boom height. According to the manufacturer, the single nozzle can be used for boom extensions or roadside spraying while the double nozzles are better suited for small broadcast sprayers. Tips are available in brass or aluminum, furnished with either brass or aluminum swivel nozzles and are available from 5 through 10 gpa.

Hay-in-a-Day The One-Man Way

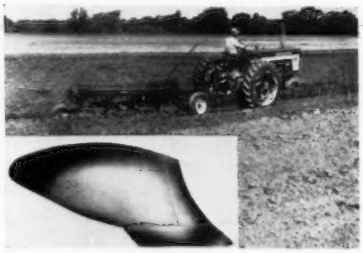
New Holland Machine Co., New Holland, Pa., has improved on its mechanized haymaking system so that it can now be

handled from start to finish by one man. Three major improvements were cited as most responsible for the progress: (a) mechanical loading of short bales in the field, (b) drying them on the wagon, and (c) moving them into storage by a new kind of elevator-conveyor system designed for use by one man.

Use of random-stacked short bales receives credit as the key to this advance. Recent tests conducted by Pennsylvania State University reportedly showed that a wagon with 6-ft sides holds as much hay in the 16-in. bales, tossed into a wagon by a bale-thrower, as a regular four-layer load stacked by hand. Furthermore, random-stacked bales are said to dry better than standard hand-stacked bales. Wagon-drying of bales is done by crop drying machines which blow hot air into a nylon hood covering the wagon. After drying, the bale carrier, using an elevator-conveyor, gets the bales from a hopper feeder and carries them into the hay mow. Bales may be dumped off either side of the conveyor at any point by means of two ropes which control a bale locator device.

Improved Plow Bottom Design

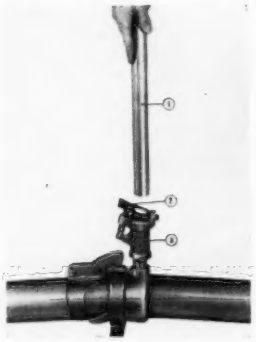
International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill., has introduced new high-speed (Super Chief) plow



bottoms, with throw-away shares, which are designed to provide more uniform seedbeds, wider furrows for additional tire room and better coverage of trash at high plowing speeds. Featuring a new moldboard curvature design, the new bottoms reportedly show improvements in leaving fields smooth and level and when plowing in sod furrow slices turn better without breaking ribbons, while stubble soil crumbles without ridging. All shares are 3/8-in. thick. Flat shares also are available in 5/16-in. thickness.

Riser Quick Coupler Offered

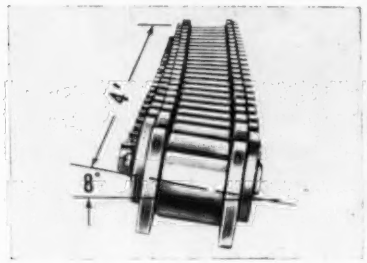
John Bean Div., Food Machinery and Chemical Corp., Lansing 4, Mich., has announced a new riser quick coupler cast of corrosion-resistant aluminum alloy for use with all sprinkler irrigation systems with 1-in. riser outlets. It is designed for use on older systems already in use as well as new systems. A downward push locks the



riser (1) in place in the quick coupler (3) without twisting or turning. It is held in position by a spring-operated grip plate. To remove, the tow plate (2) is depressed and the riser lifted out with the riser outlet being automatically closed.

New Heavy-Duty Roller Chain

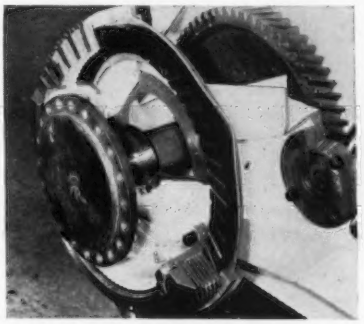
Diamond Chain Company, Inc., Indianapolis 7, Ind., has introduced a new roller chain (Tuf-Flex) designed for extra dur-



ability and flexibility. Extra clearance between linkplates and between pins and bushings permits up to 4-in. lateral displacement and 8-deg twist for each 4 ft of chain to accommodate sprocket misalignment. Straight linkplates, by transmitting loads in a straight line reportedly provide greater load capacity and withstand higher shock and peak loading. The new chain is available in four pitch sizes manufactured to meet both military and ASA specifications and permit installation on sprockets cut for offset sidebar chain and standard roller chain. A 4-page folder No. 2600, listing specifications, prices and construction features of the chain, may be obtained from the company.

Pyrotex Wheel Brake Part

Raybestos-Manhattan, Inc., Equipment Sales Division, Bridgeport, Conn., developed a Pyrotex molded pressure plate, engineered for air brake assemblies used on wheeled earth-moving equipment. Shown in photo is a wheel air-operated brake assembly by

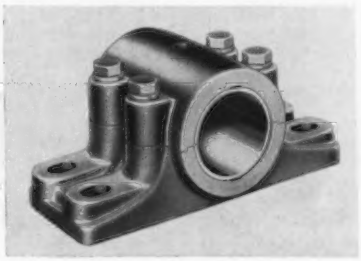


LeTourneau-Westinghouse Co., which is used on both prime mover and trailer vehicles. From lower center to right, alternate lined and coated steel disks which provide braking action about Pyrotex molded plate. Pyrotex, an asbestos-reinforced plastic, was selected for its qualities of high structural strength, insulation, and ability to withstand high braking temperatures generated under harsh field operating conditions.

In schematic drawing (from left), plate, rubber diaphragm, retainer, Pyrotex pressure plate, alternate lined and coated steel disks, backing plate, hub and snap ring.

New Bronze-Bushed Pillow Block

Dodge Manufacturing Corp., Mishawaka, Ind., has developed a new design in which bronze precision liners can be replaced



quickly and easily in pillow blocks. The new sleeve bearings are said to be adapted for applications where shock loads, elevated temperatures and corrosive conditions are anticipated. The new design permits a worn bushing, or liner, to be replaced without removing the bottom half of the housing from its support. The new line includes split journal bearings (two-bolt) for standard power transmission shaft sizes from $1\frac{15}{16}$ to $2\frac{15}{16}$-in.; rigid pillow blocks (four-bolt) for shafts from $3\frac{7}{16}$ to 8 in., and angle pillow blocks for all standard transmission shafts.

Universal Wheel Groups

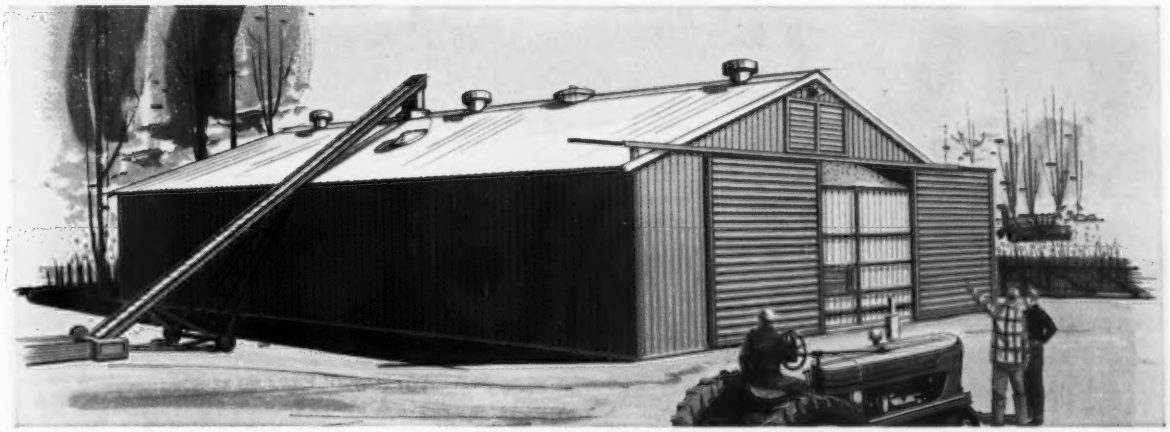
Motor Wheel Corporation, Lansing, Mich., has announced that interchangeable wheels for trailers and passenger cars are now available. The new universal wheel group eliminates the necessity for a motorist to carry a spare for his utility trailer.

(Continued on page 398)

GRAIN-MASTER "24"

dollar-saving farm-sized grain storage for livestock feeders and cash-grain growers

Stran-Steel's new Grain-Master "24" pre-engineered building makes common sense for livestock feeders and cash-grain growers alike. It loads to capacity without interior handling. Steep roof slope matches natural slope of piled grain. Pick the size to fit your needs—24 feet wide, any length in multiples of 16 feet. Grain-Master aeration system controls moisture migration—and it's also available with drying systems for small grain and ear corn. Ideal for both grain and equipment storage—a movable bulkhead separates grain from other stored items. Choose from nine sparkling new Stran-Satin protective colors! For complete information, mail the coupon or call your local Stran-Steel dealer.



Stran-Steel®

Stran-Steel Corporation, Dept. AE-15
Detroit 29, Michigan

Send the new Grain-Master "24" catalog and information on Stran-Satin Color. I'm interested in a building approximately _____ ft. x _____ ft. to be used mainly for _____

Name _____ ☐ Student

Address _____ Phone _____

City, State _____

STRAN-STEEL IS A DIVISION OF **NATIONAL STEEL CORPORATION**

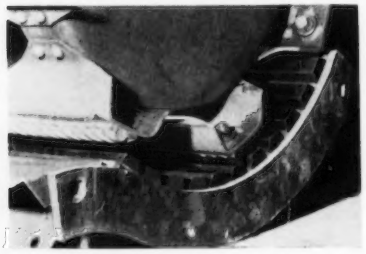
. . . New Products

(Continued from page 397)

There are four universal trailer-passenger car wheel groups. The first group consists of a hub and drum assembly, and a hub and stud assembly for the 5-bolt, 4-in. bolt circle, 13-in. passenger car wheels. The second group will accommodate 14, 15 and 16-in. wheels on a 5-bolt, 4½-in. bolt circle. The company can also provide a new wheel cover for production nubbin type 15-in. and 14-in. passenger car wheels. The third group is a hub, and hub and drum group for 5-bolt, 4¾-in. bolt circle wheels. The fourth group is a similar group for the 5-bolt, 5-in. bolt circle wheels.

Rubberized Concave Bars

Robt. M. Morgan Co., McMinnville, Ore., has developed rubberized concave bars which reportedly can be bolted to the con-



cave of most rasp-bar combines manufactured since 1948, thus providing a new type of threshing surface. No remodeling of the concave is said to be required for use of these rubberized bars. The bars are placed side-by-side to create a closed threshing surface. The manufacturer reports that less cracking of seed and less internal seed damage occur and that additional seed crop recovery results.

Chopper Attachments

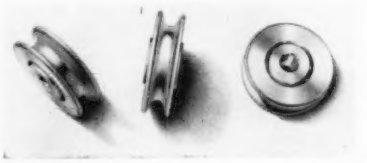
Lundell Mfg. Co., Inc., Cherokee, Iowa, has introduced another new attachment for the model Super 60 chopper in the form of

an extension to increase the cutting width and capacity as well as offer a choice of either a 5 or 8½ ft cut. The extension may be attached or detached by pulling or installing two pins and a belt. It may be raised or lowered from the tractor seat to facilitate cutting for ridges and borders or for transport.

Also available as attachments are the basic hay head, the one-row corn head, the two-row corn head, the hay conditioner and grinder attachment.

New Ball Bearing Pulleys

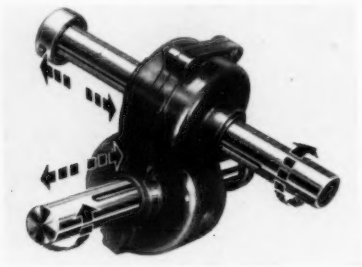
Syracuse Bearing Co., 428 E. Jefferson St., Syracuse, N. Y., has introduced a new series of ball bearing pulleys, for use with rope, wire rope or cable. Six standard sizes are designed to handle cable sizes up to ¼ in. in diameter. O.D.'s range from ⅞ to 2 in., and bores from 3/16 to ⅜ in.



The bearing rings of these units are made of case hardened steel. Grooves are tapered and rounded. A catalog listing of stock sizes is available from the company.

Universal Floating Right-Angle Gear Drive

Tol-O-Matic, Inc., 246 Tenth Ave. S., Minneapolis 15, Minn., has introduced a new floating right-angle gear drive designed



to meet the needs of many applications requiring power transmission at right angles with a 1:1 ratio. Installation of the drive consists of assembling gears and housings around the shafts. The floating feature permits self-alignment and automatic adjustment on the driving and driven shafts.

Twin-Rib Re-Roofing Sheets

Kaiser Aluminum & Chemical Corporation, Kaiser Center, 300 Lakeside Dr., Oakland 12, Calif., has developed a new light-

weight aluminum sheet designed primarily for re-roofing and siding. The new product called Twin-Rib is diamond embossed with an exclusive pair of ribshaped corrugations spaced 8 in. on center and weighs 27.1 lb per square. The flat areas between the ribs are approximately 5 in. wide.

Moisture-Measuring Instrument

Advanced Instrument Corp. (ADVINCO), 700 South 4th St., Richmond, Calif., has introduced a moisture-measuring instru-

ment, the Xerometer precise hygrometer, responding only to water and capable of reading relative moisture content over a wide range at extremely high or low temperatures. It reportedly is unaffected by most common solvents and other non-corrosive materials. The device indicates directly the relative moisture content of gases (air, carbon dioxide, oxygen and many others), liquids (alcohol, acetone, gasoline, and petroleum products, etc.), and solids (wood, soil, grain, chemicals and the like).

High-Precision Ball Bearings

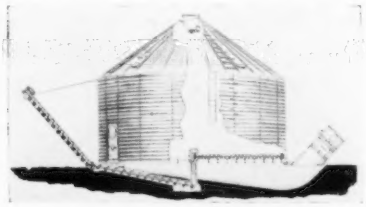
Split Ballbearing, Div. of MPB, Inc., Lebanon, N. H., has announced its new high-precision type HDR radial ball bear-

ings designed for increased load capacity and longer life. The new bearing features single-fracture design. The manufacturing method consists of fracturing the outer ring of the bearing at one point, spreading it sufficiently to allow the assembly of a maximum complement of balls. Full depth, symmetrical raceways are used. The one-piece, outer land-riding bronze retainer reportedly improves internal lubrication, and permits high operating speeds.

Offered in ABEC-3 and ABEC-5 precision grades, the new bearings are made in extremely light, extra light, light, and medium series, in metric sizes up to 85 mm O.D. Standard material for rings and balls is 52100 steel. Four ranges of internal clearance are available. Catalog 60, giving complete engineering information, is available from the company.

New Drying Bins

Behlen Manufacturing Co., Columbus, Neb., has announced two high-capacity natural air drying bins designed to be used

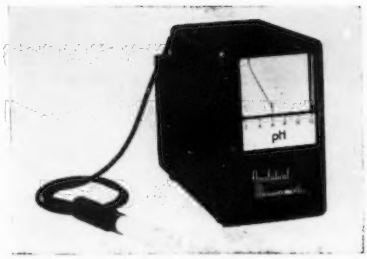


for storage when not in drying use. According to the manufacturer up to 2,900 bu of 30 percent moisture corn can be dried in one batch. Then, additional layers of corn can be added, dried, and stored.

Both bins (6,600 and 10,000 bu in size) are 26 ft, 9 in. in diameter. Wet grain is loaded through the top cap and automatically leveled by a power loading leveler. Other standard equipment includes a center unloading tube, four roof hatches for easy access and air outlet, and a walk-in door on the smaller model. Optional equipment includes an unloading auger, a radial sweep auger for complete automatic unloading, and a supplemental heat unit.

Recording pH Meter

Analytical Measurements, Inc., 585 Main St., Chatham, N. J., has announced a recording pH meter for providing a continuous permanent record of pH changes. The new instrument utilizes an electronically modulated amplifier that compensates for line voltage fluctuations and uses standard radio tubes. A strip chart recorder forms the front panel of the instrument and



contains a 63-ft roll of chart paper that will last for 31 days at 1 in. per hour. Other chart speeds are available. Connections for insertion of a platinum resistance thermometer provide automatic temperature compensation. A switch on the front panel permits disconnection of the chart drive so that the instrument becomes an indicating pH meter.

. . . Events Calendar

(Continued from page 386)

August 15-23 — 7th *International Soil Science Congress*, University of Wisconsin, Madison. Additional information may be obtained from Richard Bradfield, president, ISSC, Dept. of Agronomy, Cornell University, Ithaca, N.Y.

August 22-26 — 2nd annual *Western Resources Conference*, University of Colorado, Boulder. Contact Chairman M. E. Garnsey, professor of economics, University of Colorado, Boulder, for details.

August 28-31 — *Soil Conservation Society* 15th Annual Convention, Ontario Agricultural College, Guelph, Canada. For specific information write to: Soil Conservation Convention, Department of Soils, Ontario Agricultural College, Guelph, Canada.

September 6-16 — *Production Engineering Show*, Navy Pier, Chicago, Ill. Will run concurrently with *Machine Tool Exposition*. Clapp & Poliak, Inc., 341 Madison Ave., New York, N. Y., may be contacted for complete information.

September 12-17 — *Pan American Congress on Engineering Education*, Buenos Aires, Argentina, S. A. Write to Engineers Joint Council, 29 W. 39th St., New York 18, N. Y., for further information.

September 13-15 — *Farmstead Engineering Conference on Confinement Housing of Livestock*, Lincoln Hall Theatre, University of Illinois, Urbana, Ill. For further information write to the American Society of Agricultural Engineers, 420 Main St., St. Joseph, Mich.

September 21-23—7th annual *National Electric Farm Power Conference*, Kentucky Hotel, Louisville, Ky. For information write to: Inter-Industry Farm Electric Utilization Council, Inc., P.O. Box 577, Washington 4, D.C.

September 26-29 — Fall Meeting of *The American Welding Society*, Penn-Sheraton Hotel, Pittsburgh, Pa. Contact AWS headquarters at 33 W. 39th St., New York 18, N.Y., for details.

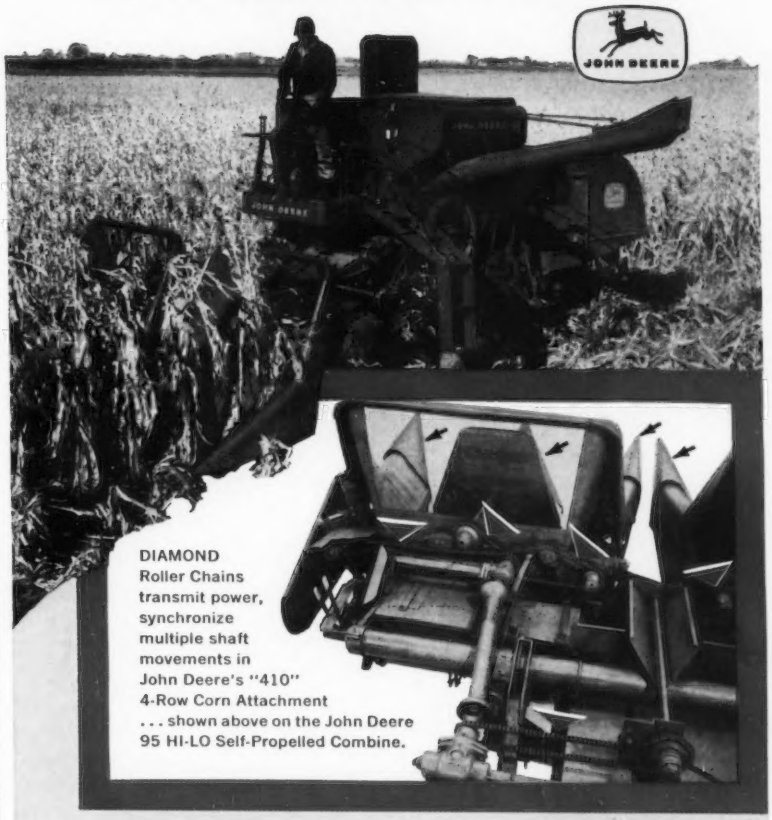
October 10-14 — 15th annual *National Hardware Show*, Coliseum, New York, New York. Details may be obtained from Ted Black, Public Relations, Medical Arts Bldg., Reading, Pa.

October 19, 1960 - September 14, 1961—4th *International Course in Hydraulic Engineering*, Delft, the Netherlands. Further particulars may be obtained from the Netherlands Universities Foundation for International Cooperation, 27 Molenstraat, The Hague, Netherlands.

4000 bushels of corn per day

...easy pickings for the John Deere equipped with

DIAMOND ROLLER CHAINS



DIAMOND Roller Chains transmit power, synchronize multiple shaft movements in John Deere's "410" 4-Row Corn Attachment . . . shown above on the John Deere 95 HI-LO Self-Propelled Combine.

For more than 70 years manufacturers of farm machinery have recognized the dependability and operating economy of DIAMOND Roller Chain. Its ready adaptability to a wide range of multiple shaft movements and center distances helps simplify design problems. For the equipment buyer, DIAMOND'S great reserve strength and long life minimize downtime, maintenance and replacement costs.

DIAMOND Engineering Service is available to you. Write to the Sales Engineering Department, giving full details.

DIAMOND CHAIN COMPANY, INC., A Subsidiary of American Steel Foundries

Dept. 616 • 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS

UNITCASTINGS provide answer for difficult parts problem!

Again, Unitcast Foundry Engineering proved invaluable in producing this hydraulic valve body casting.

Faced with the necessity of a durable, more compact unit, the customer investigated the advantages of *cast steel*. Firm specifications included small and irregular internal passages that were impossible to machine blind. Tolerances were close and exceptionally clean internal surfaces were a necessity. Shell cores, as illustrated, were used in a green sand mold. The system was streamlined and the more compact unit did not hamper the mechanism. Costs were reduced to a fraction of the alternate composite machined assembly.

Unitcastings can possibly meet your unusual problems, too. Why not investigate today . . . call for a Unitcast Sales Engineer.

UNITCAST CORPORATION, Toledo 9, Ohio
In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Agricultural and Industrial Wheels

Motor Wheel Corp., Lansing 3, Mich. — A 50-page, illustrated and cross-referenced, agricultural and industrial wheel catalog contains full information and technical data on company's complete line of "application engineered" wheels. Included in the listing are trailer, press and gage, implement, tractor, variable tread tractor, power adjusted, off the road, and grader wheels; plus hubs, hub caps, bolts, nuts, spindles, wrenches, and loose rims.

Cross Perforated Metal Brochure

Cross Perforated Metals Plant, National-Standard Co., Niles, Mich. — A 40-page brochure, No. 8159, outlines engineering data for complete specification of heavy-gage perforated metal. Data includes applications, directions for pattern specification, dimensions, unit weights, calculation of open area, materials selection, fastening methods, and equivalence tables relating wire cloth to square, round and cross hex-creen patterns.

Nickel Alloy Steels

The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. — A 76-page, illustrated book entitled "Nickel Alloy Steel and Other Nickel Alloys in Engineering Construction Machinery" describes and illustrates the types and properties of materials; power components; motive units; and construction machinery.

Spherical Roller Bearings and Pillow Blocks

Link-Belt Company, Department PR, Prudential Plaza, Chicago 1, Ill. — A 60-page book, No. 2753, entitled "Link-Belt at Work" is a directory describing the facilities, products, engineering activities, and services of the company; Book No. 2760, 52 pages, describes line of highest capacity spherical roller bearings; Folder No. 2976, a 4-color brochure, describes spherical roller bearings in detail and gives specification tables; Form No. A2445, a 4-page specification sheet and two 4-page service instruction bulletins, Nos. 3111 and 3112, for cylindrical and tapered bore spherical roller bearings.

Power Unit Bulletin

Allis-Chalmers Mfg. Co., Tractor Group, Milwaukee 1, Wis. — An 8-page, 2-color bulletin, No. BU-589 describes the G-138 power unit and includes specifications for both power unit and engine.

Atomic Energy Facilities Booklet

Allis-Chalmers Mfg. Co., Atomic Energy Division, Milwaukee 1, Wis. — Bulletin No. 43B9541, a 24-page booklet entitled "Atomic Energy at Allis-Chalmers" describes and portrays some of the company's accomplishments in design and construction of reactors here and abroad, and includes information on the many resources and services which its atomic energy division can provide, along with a discussion of the division's technical personnel and research and production facilities devoted to atomic energy problems.

Caterpillar Literature

Caterpillar Tractor Co., Peoria, Ill. — The following six pieces of literature are offered:

Three velocity tables for use in determining rippability through seismic analysis,

plus a roundup story explaining how contractors are using this technique in bidding and equipment scheduling, the scope of its use, where the seismograph may be purchased and the testing procedures.

Booklet 20173, an 8-page, illustrated brochure entitled "Caterpillar Natural Gas Engines" describes complete line of company's natural gas engines for all applications, traces their development, shows model views, specifications and fuel consumption curves.

Form D942, a 20-page, 2-color, illustrated bulletin entitled "Caterpillar Construction Equipment" is a reference catalog for the complete line of company's earthmoving equipment and its diesel engines, containing model views and brief specifications.

Form 33443, an illustrated 16-page, 2-color booklet entitled "King of the Crawlers" describes the D9 Series E tractor and explains design features. Also included is a complete listing of all matched equipment.

Form 33557, an 8-page, 2-color, illustrated brochure entitled "Caterpillar Rippers" gives construction details and operation of rear-mounted, hydraulically-operated rippers for the company's D9, D8, D6, and D4 tractors and the 977 and 955 traxcavators.

Booklet D003, an 8-page bulletin entitled "Bargain Acres for Your Farm" describes and illustrates how the small, unimproved problem acres can be turned into a profit-making part of the farm.

Spray Mulch

Alco Oil and Chemical Corp., Trenton Ave. and William St., Philadelphia 34, Pa.—An 8-page, 4-color booklet describes and illustrates the spray mulch, Vulcanol. It also lists applications and equipment required, recommended dilutions, typical Vulcanols, and the colors in which they are available.

Plastic Samples and Data Kit

The Iten Fibre Co., Iten Ave., Ashtabula, Ohio — The "Iten-Idea Kit" provides actual specimens of industrial plastics and fibre materials for experimental tests, coupled with graphic and descriptive data useful in product design and development. All samples are selected in contrasting categories to afford a complete, detailed study of each material and its manufacturing potentialities. Requests for the free kit should be submitted on company letterhead.

Cylindrical Roller Bearings

Hoover Ball and Bearing Co., Bearing Division, 5400 S. State Road, Ann Arbor, Mich. — A 12-page, illustrated bulletin, No. 114, contains dimension, load and other application information on cylindrical roller bearings.

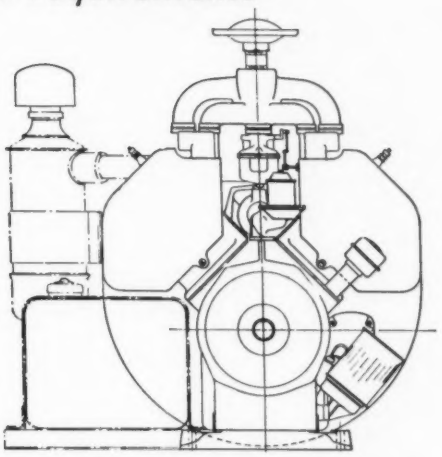
Feed Bunks Brochure

New Holland Machine Co., Div. of Sperry Rand Corp., New Holland, Pa.—"How to Build 3 Kinds of Feed Bunks" is the title of a brochure containing building tips and estimated costs for a masonry block and wood bunk, a poured concrete bunk, and a pole type bunk. Construction details for each type are also included.

V-Belt and Industrial Hose Catalog

Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill. — A 52-page catalog, No. 260 is punched for notebook insertion, lists the complete line of industrial V-belts, including cog-belt and poly-V and fractional horsepower types, as well as sheaves and industrial hose, and includes data on sizes, dimensions and prices. A special section on hose lists information on molded and horizontal braided, machine-built wrapped fabric, hand-built wrapped fabric, and woven jacket hose.

Let Wisconsin Engineers help you meet your power requirements



by modifying Wisconsin Engines to your individual needs with these

CUSTOM ENGINEERED

accessory options

For every production-model Wisconsin Heavy-Duty Air-Cooled Engine — 3 through 56 hp. — we offer a wide choice of assembly-ready modifications. These include, among other options: fuel and electrical systems, speed-regulation controls, power drive, fuel-tanks, and various other options.

But Wisconsin *custom engineering* goes beyond these options. Where your equipment operating and installation conditions require specialized engineering, our engineers will work with you to meet your needs most satisfactorily.

Here is a helpful service that can save you development time and experimental cost. More than 50 years of engine application and production experience are at your command.

Brief us on your power problem in terms of equipment and operating requirements. You'll find our seasoned counsel helpful and cordially cooperative.

Write today for Bulletin S-249, with condensed "specs" and general data covering the complete Wisconsin Engine line. Address: Dept. O-40.

ACCESSORY OPTIONS

FUEL SYSTEM — gasoline, natural gas, or LPG (for domestic use) and alcohol, kerosene, or No. 1 fuel oil (for export).

ELECTRICAL EQUIPMENT — electric starter-generator system or electric starter only for all models. Solenoid switches and automatic choke, for remote or automatic starting, also available.

HYDRAULIC POWER — all Wisconsin V4's can be equipped with integrally-mounted hydraulic pump.

POWER DRIVE—centrifugal clutch; over-center clutch; clutch reduction or reduction assembly in a variety of ratios; adaptor to take a spring-loaded clutch; or transmission-torque converter designs.

DIRECT DRIVE — special crankshaft extensions are available threaded, tapered, splined, special diameters and lengths, various keys, etc., for close-coupled pumps, generators, and other equipment.

SAFETY DEVICES — low-oil-pressure cut-off switch for 2- and 4-cyl. models, and high-temperature safety switch for all models.

OTHER ACCESSORIES — automotive and spark-arresting mufflers, pre-cleaners, drive pulleys for flywheel, rewind starters for ACN and BKN engines, and others.

WISCONSIN MOTOR CORPORATION
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

Positions Open (1959) – **December**–O-378-974, 384-975, 370-980, 394-981. (1960) **January**–O-441-985, 452-986. **February**–O-4-601, 11-602, 35-605. **March**–O-55-606, 57-608, 66-609, 83-610, 21-611. **April**–O-105-612, 111-613, 114-614, 95-616, 126-617. **May** – O-169-618, 171-619, 187-620.

Positions Wanted (1959) – **December**–W-390-59, 388-60. (1960) **January** – W-411-61, 426-62, 427-63, 433-64. **February** – W-3-1, 10-2, 15-3, 16-4, 17-5, 5-6, 33-8, 37-9, 30-10. **March** – W-46-11, 63-13, 62-14, 77-15, 69-16, 73-18, 74-19, 76-20, 94-21. **April**–W-90-23, 99-24, 102-25, 96-26, 110-27, 127-28, 12-29, 117-31 120-32, 121-33. **May** – W-101-34, 140-35, 129-36, 156-38, 175-39, 119-40, 158-41, 170-42, 182-43, 103-44.

NEW POSITIONS WANTED

Agricultural Engineer for design, development, research, sales, service, or writing in power and machinery field with manufacturer, processor, or trade association. West Coast preferred. Other locations considered. Travel as required. Married. Age 30. No disability. BS & MSAE, 1954 and 1956, Oregon State College. Farm background. Sales engineer for food processing equipment over one year. District sales manager for fertilizer manufacturer, 2½ yr. Military enlisted service before college, with Army Chemical Corps. Available on 30 days notice. Salary $8000. W-190-45.

Agricultural Engineer for design, development, research or management in power and machinery with manufacturer in Midwest or East. Limited travel. Married. Age 38. No disability. BSAE, 1948; MSAE, 1951, Michigan State University. Design engineering experience 9 years, in hydraulics, tractors, and backhoes, including supervision of up to 5 other engineers. Work with management in planning, coordinating, and administering engineering and production programs. Available on two weeks notice. Salary $10,000 range. W-191-46.

Agricultural Engineer for design, development, service or management in power and machinery or product processing with industry or public service. Any location. Northern U.S. preferred. Married. Age 38. No disability. BSAE, University of Minnesota. Farm background. Irrigation engineering and soil conservation 3½ years. Experimental, design and development engineering on paper industry equipment. Design, development and sales engineering with hydraulic equipment manufacturer past 4 years, including work on both industrial and agricultural equipment applications. War service over 3 years. Available on 4 weeks notice. Salary open. W-207-47.

Agricultural Engineer for design or development in power and machinery or soil and water field with manufacturer, processor, or experiment station anywhere in U.S.A. Will travel. Single. Age 21. No disability. BSAE, 1960, University of Maine. Farm background. Available June 12. Salary open. W-208-48.

Agricultural Engineer for design, development, sales or management in soil and water or product processing field with manufacturer, consultant, or federal agency. Any location. Limited travel. Married. Age 35. No disability. BSAE, 1950, University of California. Sales engineer 4 years. Sales manager 6 years. Military service over 2 years, before college, in chemical warfare. Available October 15. Salary $10,000. W-199-49.

Agricultural Engineer for design, development, research, extension, sales or service in power and machinery, with manufacturer, distributor, or consultant. Any location. Upper Midwest preferred. Married. No disability. BSAE, 1923; MSAE, 1924, Iowa State University. Extensive design, development, research and service experience on forage dryers, tillage tools, and sugar cane equipment. Available on reasonable notice. Salary open. W-193-50.

Agricultural Engineer for development or research in power and machinery with manufacturer. Any location. Married. Age 26. No disability. BSAE, 1957, Purdue University. Farm background. Foreman in tomato processing plant 2 years. Research engineer on earth-moving equipment, with manufacturer, 2½ years. Commissioned service with Army Engineers, 6 months. Available on 2 weeks notice. Salary $7000. W-213-51.

NEW POSITION OPEN

Agricultural Engineer (instructor) for teaching courses in farm power and farm machinery in a western state college. Also student advisory work and cooperation with other departments on scheduling classes to fit program of field operations. Age 25-45. MSAE preferred. BSAE considered. Farm background. College teaching or farm equipment industry experience desirable. Should be familiar with proper operation and maintenance of tractors and machinery. Ability and interest in teaching, agreeable personality, good cooperator, with initiative and enthusiasm to develop an outstanding program. A challenging opportunity with one of the largest and most progressive agricultural and engineering colleges in the west. Ideal, moderate California Coast climate. Starting salary $458-613 per month, depending on training and experience. Starting date September 19. O-231-62.

NEW FILM RELEASES

The Farmstead Acre. 16mm. Color and sound. The progress that is being made to increase farmstead efficiency, particularly through the development of modern steel buildings and labor-saving equipment, is the topic of this film. Nationally recognized authorities in livestock housing, machinery storage, and grain storage, tell how farmers can cut costs and build profits with more efficient buildings and machinery. Recent developments in the design of farm buildings are shown for sheep housing, poultry laying houses, citrus processing, hog farrowing, onion storage, and others. Copies may be obtained free of charge, on a short period loan basis from Stran-Steel Corp., Detroit 29, Mich.

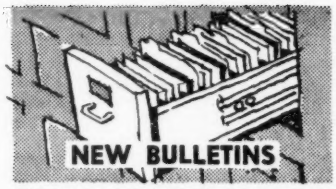
NEW LOW COST STEEL PINTLE CHAIN

Locke "600" Series Steel Pintle Chain is designed for industrial and agricultural applications where cost, adverse operating conditions, low maintenance requirements or use with cast sprockets are governing factors.

The new chain is produced to exceptionally close dimensions and pitch uniformity from high tensile, heat treated steel. A number of attachment links are available for use in conveyor applications.

Low costs result from automatic forming and assembly methods. If your application has cost limitations which prohibit use of roller or malleable pintle chain, write now for information on Locke "600" Series Steel Pintle Chain — available on request in Catalog 60.

LOCKE STEEL CHAIN COMPANY
1203 SABINE STREET, HUNTINGTON, INDIANA



The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

Progress Report on Mechanical Harvesting of Red Tart Cherries, by R. Guest, E. D. Markwardt, R. L. LaBelle, and O. C. French. Agricultural Engineering Dept., Cornell University, Ithaca, N. Y.

Testing the TBM Aerial Tanker in the Southeast, by Theodore G. Storey, George W. Wendel, and Anthony T. Altobellis. Station Paper No. 101, July 1959. Forest Service, USDA, Southeastern Forest Experiment Station, Asheville, N. C.

Sansevieria Planting Machinery, by Robert E. Hellwig and Mills H. Byron. Bulletin ARS 42-34, November 1959. Agricultural Research Service, USDA, Washington 25, D.C.

Effects of Basic Tillage Methods and Soil Compaction on Corn Production, by H. P. Bateman. Bulletin 645, June 1959. Agricultural Experiment Station, University of Illinois, Urbana, Ill.

Distribution of Water from Medium Pressure Sprinklers (summary in English), by Ido Seginer. Thesis for the degree of Master of Science, May 1959. Department of Agricultural Engineering, Israel Institute of Technology, Hatechnion, P.O.B. 4910, Haifa.

The following bulletins are available from the Institute for Land and Water Management Research, P.O. Box 45, Wageningen, Holland, and are written in English.

Technical Bulletin 3 — *The Transmission of Tidal Waves in Elastic Artesian Basins,* by J. Wesseling. 1959.

Technical Bulletin 4 — *Transpiration of Plants Under Controlled Conditions,* by J. F. Bierhuizen and P. J. C. Kuiper. 1959.

Technical Bulletin 5 — *Determination of the Capillary Conductivity of Soils at Low Moisture Tensions,* by J. Butijn and J. Wesseling. 1959.

Technical Bulletin 6 — *Crop Growth and Availability of Moisture,* by W. C. Visser. 1959.

Technical Bulletin 7 — *Calculation Methods of Potential Evapotranspiration,* by P. E. Rijtema. 1959.

Technical Bulletin 8 — *The Water Balance as a Basis for Irrigation Research,* by W. C. Visser and G. W. Bloeman. 1959.

Technical Bulletin 9—*A Statistical Analysis of the Differences Between Precipitation and Evaporation in the Netherlands,* by Ph. Th. Stol. 1959.

Technical Bulletin 10 — *Soil Science and Sprinkler Irrigation,* by W. C. Visser. 1959.

Technical Bulletin 11—*The Effect of Soil Moisture on the Growth and Yield of Vegetable Crops,* by J. F. Bierhuizen and N. M. De Vos. 1959.

Technical Bulletin 12 — *Calculation of Capillary Conductivity from Pressure Plate Outflow Data with Non-Negligible Membrane Impedance,* by P. E. Rijtema. 1959.

Technical Bulletin 13—*Growth and Water Relations of Tomato (1),* by A. A. Abd el Rahman, J. F. Bierhuizen and P. J. C. Kuiper. 1960.

Technical Bulletin 14 — *Lysimeters and the Water-Balance,* by G. W. Bloemen, and W. C. Visser. 1960.

Automatic Sampling of Cotton at Gins, by C. Scott Shaw and Gerald N. Franks. Bulletin ARS 42-33, January 1960. Agricultural Research Service, USDA, Washington 25, D.C.

Report of the Conference on Supplemental Irrigation, Commission VI, International Society of Soil Science, Copenhagen, 1958. Several of the above mentioned bulletins are included in this report. Available from the Institute for Land and Water Management Research, P.O. Box 35, Wageningen, Holland.

Soil Moisture Depletion Under Several Piedmont Cover Types, by Louis J. Metz and James E. Douglass. Technical Bulletin No. 1207, September 1959, Forest Service, USDA. May be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 15 cents.

A Brief Report on the Study of Governmental Organization for the Water Resources of the Delaware River Basin, by the Maxwell Graduate School, Syracuse University, Syracuse, N. Y. Water Research Foundation, 1959.

The following test reports may be obtained from the Agricultural Machinery Administration, 7th and Hamilton, Regina, Saskatchewan, Canada:

Test No. 160 — *Report on Farm Tractors, 1960.* April 1960.

Test No. 359 — *Report on Test of Case 915 One-Way Disk with Seeder (15 foot size).* April 1959.

Test No. 459 — *Report on Test of Case CP 15S Chisel Plow (15 foot size).* March 1960.

Test No. 559 — *Report on Test of John Deere No. 114 Tool Carrier (14 foot size).* March 1960.

Test No. 659 — *Report on Test of McCormick No. 50 Chisel Plow (14 foot size).* March 1960.

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A Full Line of 14"
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With increased availability of 14-inch tires you'll want to offer 14-inch wheels on your equipment. Motor Wheel has a full line of 14-inch agricultural wheels with 4, 5 and 6-bolt SAE mountings . . . light and heavy-duty series.

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

New Roof Truss for Farm Buildings

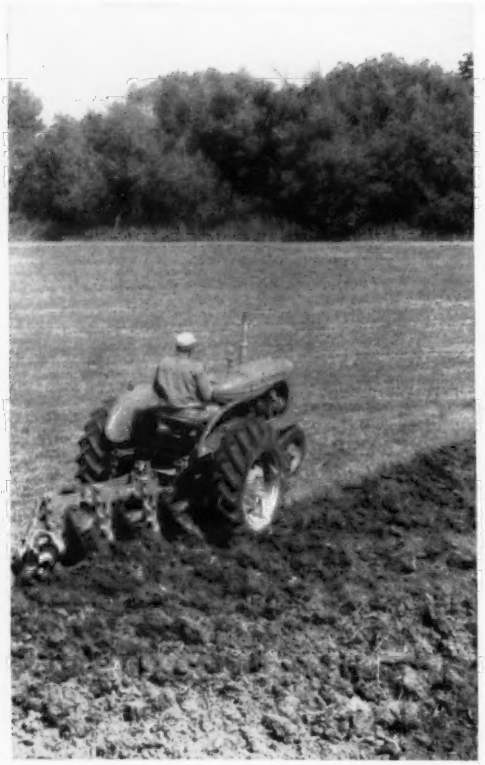
Several desirable features are incorporated in a new farm building roof truss developed by USDA agricultural engineers.

This wood truss has balanced design and is lightweight, inexpensive, and easily fabricated. The designers claim that it will safely support 125 lb per lineal foot, over a span of 24 ft, and that nailed joints are as strong as connected members.

Economy is achieved through the balanced design and wood construction. Only about 70 board feet of lumber (all 2 x 4's) and about 1½ lb of 16d nails are needed to build each truss 24 ft long. No elaborate construction jig is required.

An average farm worker should be able to construct one truss in less than an hour, because no precision cuts are necessary. Top of the truss is wide enough to be walked on while roofing purlins are applied.

The new truss was designed and tested by AERD agricultural engineers T. E. Kent, R. C. Liu, and N. C. Teter at the ARS Agricultural Research Center, Beltsville, Md. Other wood trusses, not yet tested, are also being developed there.



Spring Loaded Rockford Clutches Do the Spring Plowing

Performance in the field is the true test of your engineering skill. Knowing you have selected the right clutch designed for the job is your assurance of top results. Your customers will stay your customers. Why not take advantage of the design experience Rockford Clutch engineers can provide you at no cost. Simply provide them the specs and operating requirements, they'll supply the answers.

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ROCKFORD, ILLINOIS

Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

Revised Publication on Pig Brooding

A revised edition of "Design Requirements for Electric Underfloor Heat Brooding of Pigs" (ARS 42-18-1) has been published. It was prepared by USDA agricultural engineer J. G. Hartsock.

Copies are available from Mr. Hartsock at the Agricultural Engineering Department, Purdue University, Lafayette, Ind., or from the Farm Electrification Research Branch, AERD, ARS, Room 311, N. Bldg., USDA Plant Industry Station, Beltsville, Md.

Report on Cotton Ginning

A new research report, "Controlling Static Electricity on Cotton During Ginning with an Antistatic Agent," (ARS 42-39) is being offered by USDA.

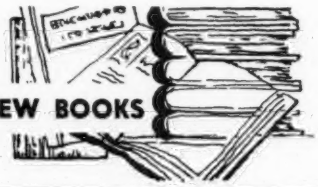
The report summarizes experiments by physicist C. G. Leonard of AERD at the Southwestern Cotton Ginning Research Laboratory, Messilla Park, N. Mex.

To obtain the report, write to Information Division, ARS, USDA, Washington 25, D.C.

Reprints of Article on Fruit Tree Hedger

Reprints of an article that describes a new fruit tree hedger are available from the Michigan Agricultural Experiment Station. The hedger was developed by agricultural engineers C. M. Hansen and S. L. Hedden.

Contact the Michigan station at East Lansing for copies of the report, "Development of a Fruit Tree Hedger." It was reprinted from the *Quarterly Bulletin*, Vol. 42, No. 3, pages 527 to 533, February 1960.



Encyclopedia of American Associations, Second Edition. Cloth. 8½ x 11½ in. 716 pages. Published by Gale Research Co., 3414 Book Tower, Detroit 26, Mich. Price, $20.00.

This reference directory is a guide to the national organizations of the United States, listing 8,892 such organizations. Grouped in 18 basic sections, including 3,000 not listed in the first edition (1956) are national associations, societies, federations, unions, and other non-profit membership organizations. Listing includes name, acronym, headquarters address, name of executive head, number of members, staff and chapters, year founded, description of membership and activities, special committees or divisions, official publication and date and place of convention or annual meeting. The sections and the number of organizations in each are as follows: 2,314 trade and commerce; 327 agricultural organizations and commodity exchanges; 163 public administration, military and legal groups. In addition, there are 293 scientific and technical, 563 education and cultural, 241 social welfare, 436 health and medical, and 117 public affairs organizations. There are also 118 fraternal, 212 nationality and ethnic, 293 religious, 86 horticultural, and 108 veterans and patriotic organizations. Other groups listed include 98 hobby and avocational, 123 athletic, 224 labor unions, 2,693 chambers of commerce (international,

bi-national, national, state and local) and 307 social, professional and honorary greek letter societies. The new volume also contains a comprehensive Finding Guide and a Subject Index.

Acronyms Dictionary, First Edition. Cloth. 5½ x 8 in. 211 pages. Published by Gale Research Co., 3414 Book Tower, Detroit 26, Mich. Price, $10.00.

This is the first edition of the acronyms dictionary, which is a guide to alphabetic designations, contractions, initialisms, etc., for associations, societies, non-profit organizations, international organizations, government agencies, United Nations agencies, business firms, colleges and universities, aerospace and electronic equipment and terms, transport facilities, military terms and general terms. Some organizations are better known by acronym than by their official title, and the wide use of the acronym today is pointed out by the more than 12,000 listings in the book. In addition to the listings, an introduction describing the development and current usage of the acronym has been provided.

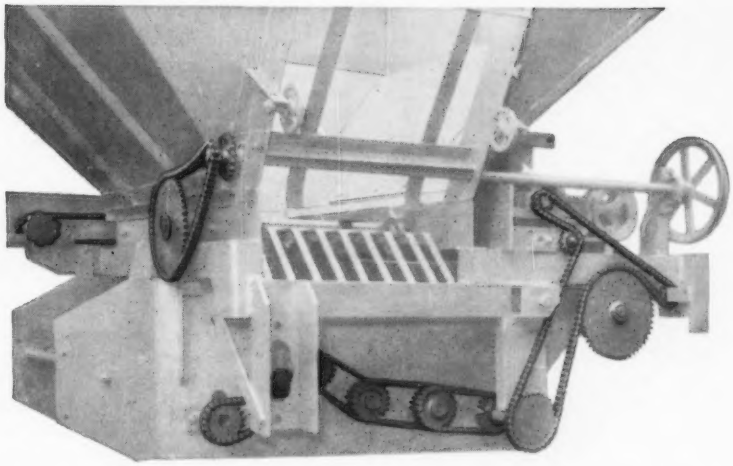
Werkstatten Zum Instandsetzen Von Landmaschinen (Work Shops for Farm Machinery), by Karl-Gunter Beger. Cloth. 17 x 24 cm. 164 pages. 78 illustrations, and 5 tables. Published by Curt R. Vincentz Verlag, Schlieszfach 8, Hannover 20 a, Germany. Price, 16.80 DM (appr. $4.00).

This book, written by an architect, serves as a guide for architects and others who are concerned with the planning and design of larger facilities for assembly, maintenance, and repair of farm equipment. The book deals primarily with the larger shops, such as commercial facilities or shops for large farming enterprises (one of the examples given is a plan for a collective farm). The book is well illustrated and includes, among others, a discussion of the major types of farm implements and their floor space requirements, and of general shop tools and equipment. Schematic planning guides for various size operations show the general shop plan, and the arrangement of special facilities (offices, paint shop, welding shop, stock and sales rooms, etc.) in relation to the main working area. A number of actual examples are given and discussed.

This well-written book, which covers practically every aspect of shop design, merits attention of everyone directly or indirectly interested in this field. As is so often the case with foreign publications, the reader may find in this book new ideas and other approaches that can be very valuable.

Pilot Project, India, by Albert Mayer and Associates in collaboration with McKim Marriott and Richard L. Park. Cloth. 6 x 9 in. xxiv+367 pages. Indexed. Published by the University of California Press, Berkeley 4, Calif. Price, $5.00.

This is the story of rural development at Etawah, Uttar Pradesh, India, where yearly the farmers watch their precious topsoil erode and their crops diminish. According to the authors, the question of how to stop the erosion not only on topsoil but, more important, of the farmers' personal productive and corporate effectiveness is significant to us all and in one form or another it confronts most of the vast rural populations of Asia and Africa. India is answering with a nationwide program derived in large measure from the Pilot Development Project of Etawah District. This book is a comprehensive study of the experiment in rural development and the story of the Project is divided into nine chapters, each chapter conveying one or several of Etawah's experiences and lessons for the larger world.



FOR CHAIN DRIVE DEPENDABILITY...

GEMCO PICKED WHITNEY!

GEMCO CART BEET HARVESTER

High speed sugar beet harvesting is tough, rugged work—hard on machinery and equipment. The reason General Machine Co., Ogden, Utah builders of the Gemco Cart Beet Harvester uses Whitney Chain and Sprockets for *eleven* different drives is:

"to insure positive driving where high power is required and to eliminate the possibility of loss of power through plugging and slipping in wet, muddy conditions."

The machine is capable of harvesting two or three rows of sugar beets, and mounts on any row crop tractor of 40 to 45 HP drawbar. The bin holds 3 tons of beets which can be unloaded in 1½ minutes.

High strength, maximum fatigue resistance, and extended wear life are characteristics built into Whitney Chain Drives through carefully controlled material selection and advanced manufacturing methods. More and more manufacturers of every type of equipment are putting their confidence in Whitney Chain Drives—the drives that are *built better to serve better.*

There is a Whitney Chain Drive in Standard or Extended Pitch to meet any requirement. Your nearby Whitney Chain Distributor can offer expert assistance in solving your drive problem. Write for the Whitney Chain Drive Catalog.

THE WHITNEY CHAIN COMPANY

a subsidiary of FOOTE BROS. GEAR AND MACHINE CORPORATION

4579 S. Western Blvd., Chicago 9, Ill.

POWER TRANSMISSION DRIVES

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Campbell, Crom B. — Pres., Campbell Farm Dryer Co., 3121 Dean Ave., Des Moines, Iowa

Clark, Nelson B. — (With the U.S. Army). (Mail) Btry. B, 4th Msl. Bn., 68th Arty. (Nike-Hercules), Coventry, R. I.

Dittmer, Willard W. — Owner, Dittmer Farm Equipment. (Mail) Higginsville, Mo.

Dodds, Russell H.—Eng. spec., (SCS) USDA. (Mail) 262 J St., Los Banos, Calif.

Dotson, Lloyd G.—Product engr., John Deere Harvester Wks. (Mail) 343 E. Park St., Geneseo, Ill.

Fish, W. John — Agr. eng. spec., Western Ontario Dist. Office, Beaver Lumber Co., Ltd., 1625 Dundas St., E., London, Ont., Canada

Gardenier, Wilhelmus J. G. — Graduate asst., agr. eng. dept., Auburn Univ., Auburn, Ala.

Gilderbloom, Gus — Pres., Bloom Builders. (Mail) 305 N. 10th St., Oskaloosa, Ia.

Gutekunst, Gerald A. — Eng. proj. leader, farm equip. div., Butler Mfg. Co. (Mail) 1245 N. Broadway, Independence, Mo.

Harlos, Bill D. — Product engr., Even-Flo Silage Distributor Inc. (Mail) R. R. 1, Kirklin, Ind.

Hay, Arthur C. — Experimental and dev. engr., Anderson, Clayton & Co., Box 2538, Houston 1, Texas

Honea, T. Milton — Product and market planning, John Bean Div., Food Machinery and Chemical Corp., 1305 S. Cedar St., Lansing, Mich.

Jones, Kenneth N.—Asst. to gen. mgr., Jones Balers Ltd., Broncoed Park, Mold, N. Wales, Great Britain (on sabbatical leave at Columbia Univ.). (Mail) 414 W. 120th St., Apt. 607, New York 27, N. Y.

Leymaster, Homer N. — Dir. of eng., Dempster Mill Mfg. Co., 711 S. Sixth St., Beatrice, Nebr.

McDougal, Luther F. — Agr. engr., (SCS) USDA, Deming, N. M.

Miller, James A.—Dir. of engr., Minneapolis-Moline Co., Hopkins, Minn.

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(Continued on page 408)

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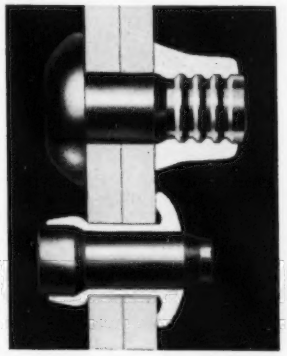

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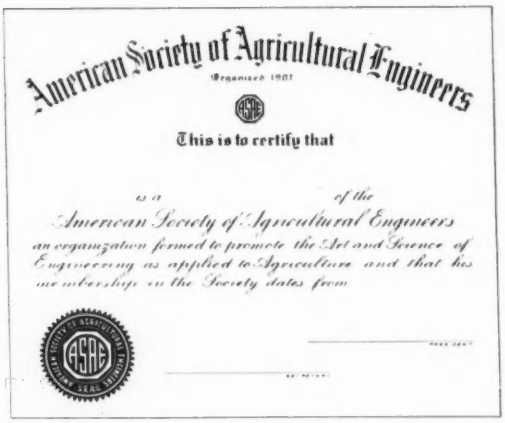
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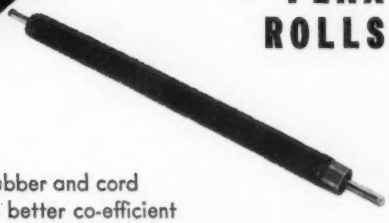

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Index to Advertisers

Aetna Ball & Roller Bearing Co. 359
Bearings Company of America Div., Federal-Mogul-Bower Bearings, Inc. 347
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc. 345
Caterpillar Tractor Co. 357
Chain Belt Co. 363
Cleveland Graphite Bronze Div. of Clevite Corp. 352
Dana Corp. 340, 341
Diamond Chain Co., Inc. 399
The Fafnir Bearing Co. 393
Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc. 343
Hammer Blow Tool Co. 408
Huck Mfg. Co. 407
Ingersoll Products Div. Borg-Warner Corp. 389
International Harvester Co. 362
Kohler Co. 353
A. Lakin & Sons, Inc. 407
Lincoln Engineering Co. 348
Link-Belt Co. 3rd Cover, 349
Locke Steel Chain Co. 402
Molded Fiber Glass Body Co. 406
Morse Chain Co. Div. Borg-Warner Corp. 337
Motor Wheel Corp. 403
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 387
Neapco Products Inc. 391
New Departure, Div. General Motors Corp. 2nd Cover
New Idea Farm Equipment Co. 355
The Ohio Rubber Co. Div. Eagle-Picher Co. 354
The Oliver Corp. 342
Perfect Circle Corp. 350, 351, 364
Raybestos-Manhattan, Inc. 358
Rockford Clutch Div., Borg-Warner Corp. 404
Rockwell-Standard Corp. Universal Joint Div. 361
Stephens-Adamson Mfg. Co. 356
Stran-Steel Corp. 397
Texaco Inc. 360
Timken Roller Bearing Co. 4th Cover
The Torrington Co. 339
Unitcast Corp. 400
Weyerhaeuser Sales Co. 395
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp. 405
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(Continued from page 406)

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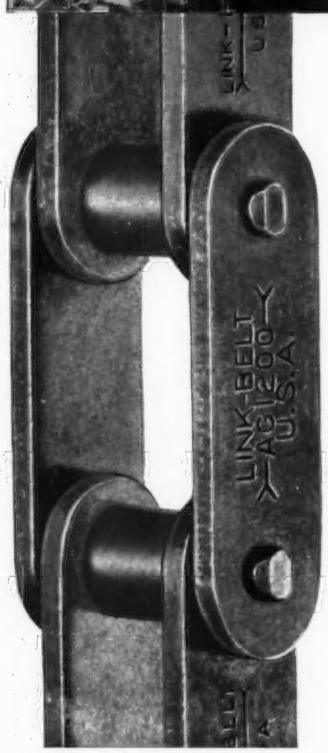

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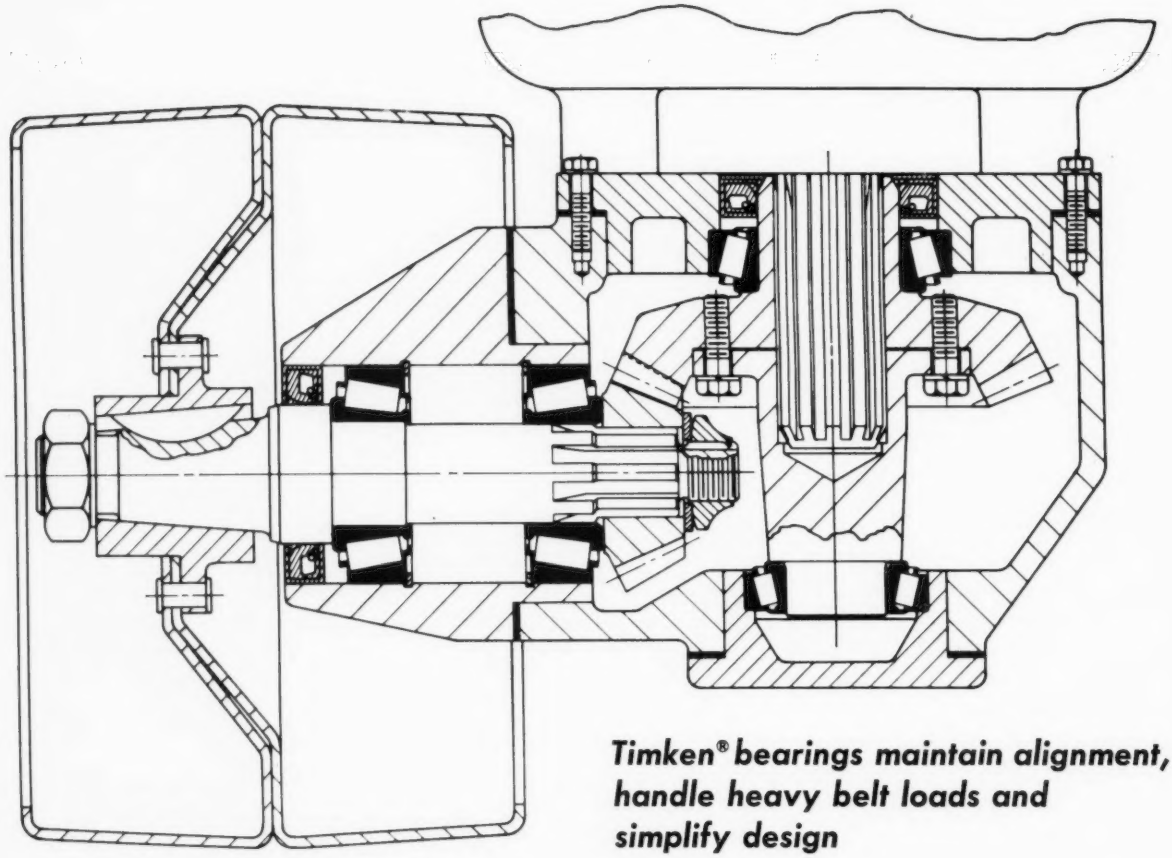

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